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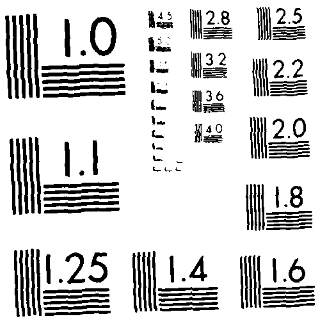

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AD-A184 474

Minnesota River at Chaska, Minnesota

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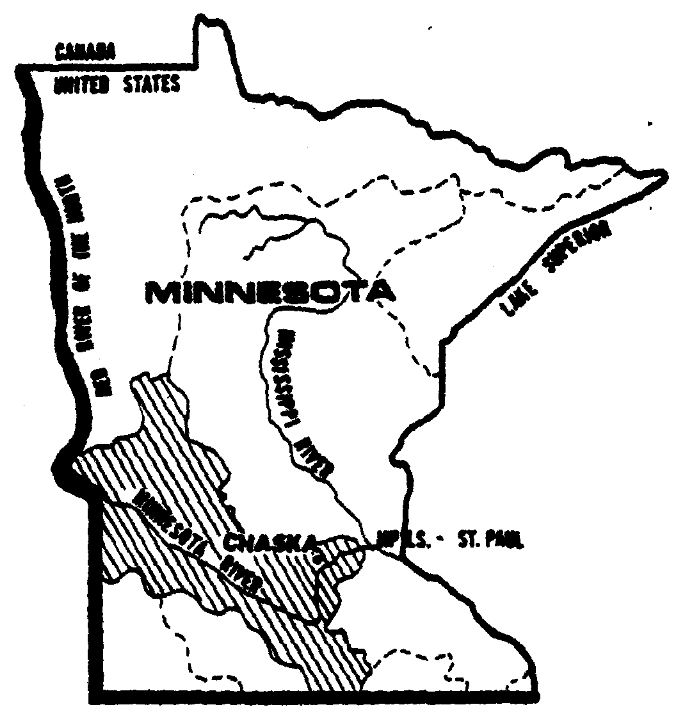

LIMITED REEVALUATION REPORT AND FINAL SUPPLEMENT TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR FLOOD CONTROL AND RELATED PURPOSES

AUGUST 1982

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TECHNICAL APPENDIXES

APPENDIX 1	PROBLEM IDENTIFICATION
APPENDIX 2	FORMULATION, ASSESSMENT, AND EVALUATION OF DETAILED PLANS
APPENDIX 3	PUBLIC VIEWS AND RESPONSES
APPENDIX 4	HYDROLOGIC INVESTIGATIONS
APPENDIX 5	GEOTECHNICAL INVESTIGATIONS AND DESIGN
APPENDIX 6	DESIGN AND COST ESTIMATES
APPENDIX 7	RECREATION
APPENDIX 8	WATER QUALITY
APPENDIX 9	SOCIAL ANALYSIS
APPENDIX 10	ECONOMIC ANALYSIS - DAMAGES AND BENEFITS
APPENDIX 11	FISH AND WILDLIFE

PROBLEM IDENTIFICATION

APPENDIX 1

LIMITED REEVALUATION REPORT

MINNESOTA RIVER AT CHASKA, MINNESOTA

PREPARED BY THE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

TABLE OF CONTENTS

TABLE

PREVIOUS CORPS STUDIES

Since 1867, the Corps has prepared numerous reports on the Minnesota River. The early reports pertained principally to improvement of the river for navigation. The reports made in accordance with the authorization contained in the 1928 Flood Control Act and subsequent acts are concerned primarily with flood control and related water resources.

a. House Document No. 230, 74th Congress, 1st session, which is a survey report dated 6 June 1935, considered the purposes of navigation and development of water power, the control of floods, and the needs of irrigation. This report recommended that further improvement for navigation, power development, flood control, or irrigation not be undertaken at that time.

b. House Document No. 669, 76th Congress, 3d session, contains a survey report dated 27 February 1940 on a general plan of improvement for the Mississippi River between Coon Rapids Dam near Minneapolis, Minnesota, and the mouth of the Ohio River. This report recommended improvements for navigation and flood control along the Mississippi River and indicated the possibility of providing further flood protection on the Minnesota River.

c. Senate Document No. 144, 84th Congress, 2d session, contains a survey report dated 10 October 1952 for improving navigation and related purposes on the Minnesota River. This report concluded that the most suitable plan of improvement would be a channel 9 feet deep and 100 feet wide from the mouth to mile 14.2[1] The River and Harbor Act of 1958,

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(1) Unless otherwise noted, all mileages refer to miles above the mouth of the Minnesota River.

Public Law 85-500, authorized construction of the navigation channel to mile 14.7 in accordance with the Senate Document.

d. House Document No. 437, 84th Congress, 2d session, contains a survey report, dated 30 April 1956, for flood control on the Minnesota River at Mankato and North Mankato, Minnesota. This report recommended raising and strengthening existing levees, constructing two short sections of floodwall, and providing for interior drainage subject to certain conditions of local cooperation.

e. House Document No. 417, 86th Congress, 2d session, contains a report dated 25 March 1960 for flood control on the Redwood River at and in the vicinity of Marshall, Minnesota. This report recommended channel improvements at Marshall and construction of a levee and a flood diversion channel subject to certain conditions of local cooperation.

f. House Document No. 579, 87th Congress, 2d session, contains a survey report dated 24 June 1960 for flood control on Big Stone Lake-Whetstone River, Minnesota and South Dakota. This report recommended a reservoir and dam on the Minnesota River above U.S. Highway 75 and 3 miles of channel improvements on the Minnesota River downstream from the dam.

g. House Document No. 193, 88th Congress, 2d session, contains a design memorandum for flood control on Big Stone Lake-Whetstone River, Minnesota and South Dakota. This report presents the final design details for the project recommended by the Chief of Engineers in House Document No. 579, 87th Congress, 2d session, and contains supplementary information on land acquisition for the national wildlife refuge system.

h. A report, dated 30 January 1970, on Minnesota River, Minnesota, 9-Foot Navigation Channel above Mile 14.7 was submitted to the Board of Engineers for Rivers and Harbors in Washington, D.C., but was returned to the District as a result of opposition expressed by various local interests No further work on the study is currently planned.

i. A Section 205 reconnaissance report dated 8 October 1965 recommended that a detailed project report be prepared to consider flood problems on the Minnesota River at Chaska and potential flooding of Chaska and East Creeks. After initiation of the detailed project study following funding by the Chief of Engineers on 21 December 1965, it became apparent that the cost of providing the desired flood protection would greatly exceed the $1 million Federal cost limitation under the Section 205 authority. A letter report submitted to North Central Division on 6 June 1968 recommended that the study be continued as an interim survey under the authority for study of the Minnesota River basin. By that time, the Minnesota River basin study had progressed sufficiently to indicate that reservoirs on the Minnesota River and its major tributaries could significantly reduce Minnesota River flood stages at Chaska. As a result, an interim study of the Blue Earth Reservoir was authorized on 10 December 1968. The Blue Earth Reservoir would, if constructed, provide a high degree of protection at Chaska from Minnesota River flood flows and was considered to be a more desirable alternative than improving the existing local levee. For that reason, the Chief of Engineers concluded that preparation of an interim report on the local protection project was not warranted. Later, it was determined that there was insufficient local support for the reservoir. On 28 February 1969, the Chief of Engineers requested that studies of improvements to alleviate flood problems at Chaska caused

by Chaska and East Creeks be continued under the Section 205 authority if a feasible project could be developed.

j. A second reconnaissance report, dated 25 June 1971, indicated that an economically feasible project could be developed to protect Chaska from flooding by Chaska and East Creeks. However, the estimated Federal cost of the project exceeded the $1 million limitation under the Section 205 authority. The city indicated that it was not capable of paying the costs in excess of the Federal cost limitation. The report recommended that the study be continued as an interim survey under the Minnesota River basin survey authority.

The reconnaissance and detailed project report studies indicated that probably the best solution to the flood problem on Chaska and East Creeks would be diversion of the flood flows of the two creeks out of the leveed area. Hydrologic studies of the two creeks have been made and preliminary diversion channel designs have been prepared. Surveys of portions of the existing creek channels were made including profiles, cross sections, and bridge sketches. Also, topographic mapping was obtained for one possible diversion route for each creek. The feasibility report also evaluated a limited number of nonstructural alternatives which were considered to be the best available at the time.

k. The plan recommended by the 1973 feasibility report was authorized for construction by the 1976 Water Resources Development Act, House Document 94-644.

STUDIES BY OTHERS

The following is a list of other reports or studies on the water and related land resource problems in the Chaska area.

1. A Plan for Recreation Trails in the Minnesota River Valley, by Itasca Engineering, Incorporated, 1969.

2. Comprehensive Plan for Chaska, Minnesota, prepared by Midwest Planning and Research, Incorporated, 1967.

3. Corridor Location Study for Trunk Highways 169, 212, and 41, by the Minnesota Department of Transportation, 1970.

4. Corridor Resource Analysis for Trunk Highway 212 near Chaska, by the Minnesota Department of Highways, 1972.

5. Field Examination Report of Chaska and Hazeltine-Vavaria Watersheds, by the U.S. Soil Conservation Service, 20 June 1967.

6. Jonathan-Design and Development Plan, prepared by the Jonathan Development Corporation, 1971.

7. Memorandum on Feasibility of Higher Dissolved Oxygen Standards for the Lower Minnesota River, by the Minnesota Pollution Control Agency, 1971.

8. Memorandum on the Waste Assimilation Capacity of the Lower Thirty Miles of the Minnesota River, prepared by the Minnesota Pollution Control Agency, April 1968.

9. Metropolitan Lake Inventory (Special Publication No. 45), prepared by the Minnesota Department of Natural Resources, Division of Game and Fish, Section of Technical Services, 1967.

10. Minneapolis-St. Paul Metropolitan Area Level B study, which includes Carver County, was initiated in July 1973 by the Upper Mississippi

River Basin Commission.

11. Minnesota Outdoor Recreation Plan, 1968.

12. Minnesota Water and Related Land Resources, First Assessment, 1970.

13. Report on Comprehensive Sewer Study for Chaska, Minnesota, by Bonestroo, Rosene, Anderlik and Associates, Incorporated, 1972.

14. Report on Water Supply and Distribution Systems for Chaska, Minnesota, by Bonestroo, Rosene, Anderlik and Associates, Incorporated, 1971.

15. Sewerage and Water Planning Report for the Twin Cities Area, by the Metropolitan Council, 1968.

16. Soil Survey, Carver County, Minnesota, by the U.S. Soil Conservation Service and University of Minnesota Agricultural Experimentation Station, 1968.

17. Southern Minnesota River Basin Type IV study, which includes the Chaska area, was completed by the Southern Minnesota Rivers Basin Board in February 1977.

18. Comprehensive Storm Water Management Plan for Chaska, Minnesota, by Bonestroo, Rosene, Anderlik and Associates, Incorporated, 1979.

19. Upper Mississippi River Comprehensive Basin Study, prepared under the supervision of the Upper Mississippi River Comprehensive Basin Study Coordinating Committee, June 1972.

20. Floodplain Areas of the Lower Minnesota River, by the U.S. Department of the Interior, 1973.

21. Flood Insurance Study, City of Chaska, Minnesota, by the Department of Housing and Urban Development, April 1977.

22. Environmental Impacts Scoping Report for U.S. Highway 212-169,

by Minnesota Department of Transportation, 1980.

23. Land Use Analysis at Chaska, Hodne Stageberg, 1979 .

24. Jonathan New Community Draft Environmental Impact Statement, by the Department of Housing and Urban Development, September 1977.

25. Report of the Minnesota River Valley Development Interim Commission, by the State of Minnesota, January 1965.

26. Water Supply and Water Quality Control, Upper Mississippi River Comprehensive Basin Study, Minnesota River Basin Planning Subarea No. 16, by the Department of Interior for the Corps of Engineers, January 1969.

27. The Effectiveness of Flood Control Structures of the Lower Minnesota River Watershed District, by Itasca Engineering, Incorporated for the Department of the Interior, Office of Water Research, and the Lower Minnesota River Watershed, July 1970.

28. Upper Mississippi River, Red River of the North, Post Flood Report 1965 Spring Floods, by St. Paul District Corps of Engineers, June 1966.

29. Minnesota SCORP (recreation needs) Report by the State of Minnesota, 1980.

EXISTING CONDITIONS; ADDITIONAL INFORMATION

SURFACE WATER CHARACTERISTICS

From Big Stone Lake in the headwaters, the Minnesota River descends about 277 feet for an average drop of 0.84 foot per mile, with very little drop downstream from Chaska. East Creek descends about 300 feet in 8 miles for an average slope of 37.5 feet per mile. Similarly, Chaska Creek drops about 300 feet in 10 miles for an average slope of 30 feet per mile.

At normal water level the Minnesota River channel averages about 250 feet wide in the Chaska area, with a bank-full capacity of approximately 7,000 cfs (cubic feet per second). East Creek varies in width from 30 to 40 feet and, at critical sections near U.S. Highway 212, has a bank-full capacity of about 500 cfs. Chaska Creek varies in width from 20 to 40 feet and has a bank-full capacity of about 1,000 cfs.

Low flows on the Minnesota River and East and Chaska Creeks occur during the late summer and fall months when evapotranspiration rates are high and also during the winter season when the river and creeks are covered with ice. During droughts, East and Chaska Creeks could be expected to have little or no flow. The average flow of the Minnesota River at Carver, Minnesota, which is just upstream from Chaska, is 3,306 cfs or about 0.20 cfs per square mile of drainage area. This average flow is about 42 times greater than the recorded low flow of 79 cfs in 1955. The biological and chemical quality of the Minnesota River at Chaska varies with the seasons but can be described as fair. Relatively high nutrient levels are often present, and the river is generally quite turbid.

The Minnesota River flows southeast from the western border of

Minnesota to Mankato, Minnesota. The river then flows to the northeast and joins the Mississippi River near Minneapolis-St. Paul.

The city of Chaska is located in Carver County, Minnesota, on the left bank (north side) of the Minnesota River (mile 29.6) about 20 miles southwest of Minneapolis. Most of the older developed portion of the city is located on the floodplain. At Chaska the Minnesota River drains an area of about 16,600 square miles. Chaska Creek, with a drainage area of about 15 square miles, flows through the west end of the city. East Creek, with a drainage area of about 11.8 square miles, flows through the northeast side of the city. Both streams flow generally in a southeasterly direction before they enter the Minnesota River, which flows easterly to its confluence with the Mississippi River.

The drainage basin of the Minnesota River upstream of Chaska consists of gently undulating prairie at elevations ranging from 700 to 1,500 feet about sea level. The Minnesota River floodplain at Chaska begins at elevation 705 and averages about a mile in width at elevation 730. Much of this area consists of marshes or lakes. The main part of the city lies between elevations 710 and 730. An alluvial terrace rises above the older part of Chaska and the Minnesota River floodplain to form a prominent bench at about elevation 750. From this terrace the river valley walls rise steeply to form a bluff generally at elevations 850 to 900. Upland areas (elevations 850 to 1070) range from poorly drained marshy areas in the Chaska Creek watershed to rolling hills in the East Creek drainage area. Both creeks flow through deep, steep-walled valleys each about a mile long before emerging on the terraced area of the Minnesota River valley. Two natural lakes, Lake Bavaria, 201 acres, and Hazeltine Lake,

236 acres, lie in the extreme headwaters of the East Creek watershed. The Chaska Creek watershed has numerous marsh-type impoundments but no large lakes. Two abandoned clay pits filled by groundwater serve as park areas in the developed part of Chaska. One of these clay pits, Courthouse Lake, gets its name from the Carver County Courthouse which overlooks the lake.

DAMAGE SURVEY - FLOOD OF RECORD

After the 1965 flood, the St. Paul District staff worked with the city to obtain an estimate of flood damages sustained. Other information obtained included values of dwellings, depth of flooding, number of persons evacuated, and how long people were displaced from their homes.

There were 181 families evacuated for an average time of 33 days during the 1965 flood. There were 17 homes with second floor or attic flooding, 136 homes with first floor flooding, and 80 homes with only basement flooding. There were 12 businesses with first floor flooding and 4 with only basements flooded.

The table below contains a summary of the damage information obtained. More detailed information about flood damage estimates at Chaska is available in Appendix 10, Economic Analysis.

Damage information - 1965 flood

Item	Actual damages	Damages at 1980 prices
Elevation 722.24		
Discharge 117,000 cfs		
City damages	$116,500	$371,600
Emergency flood protection	178,900	570,700
Volunteer help	55,100	175,800
County Courthouse	195,000	622,000
National Guard	7,800	24,900
Red Cross	46,500	148,300
Business damages	100,400	320,300
Residential damages	995,200	3,174,700
Levee repair	11,300	36,000
Total	1,706,700	5,444,300

FORMULATION, ASSESSMENT & EVALUATION OF DETAILED PLANS

APPENDIX

LIMITED REEVALUATION REPORT

MINNESOTA RIVER AT CHASKA, MINNESOTA

2

PREPARED BY THE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

APPENDIX 2

FORMULATION, ASSESSMENT, AND EVALUATION

OF DETAILED PLANS

TABLE OF CONTENTS

TABLES

FIGURE

MINNESOTA RIVER LEVEE

Levee formulation consisted of two basic activities: (1) selecting the alignment and (2) analyzing the level of protection. Both of these activities relied heavily on the economic analysis because of the marginal economic feasibility of the authorized plan.

The city has already constructed a levee, and the existing levee alignment was used as much as possible. Most of the Federal project levee would consist of adding impervious fill to the existing levee. It was necessary to recommend new sections of levee, but most of the length of the existing levee will be used in the Federal project.

The east end of the existing levee follows the western edge of Courthouse Lake, leaving the lake vulnerable to Minnesota River flooding. The Minnesota Department of Natural Resources maintains a trout fishery in the lake. The department has expressed support for a levee alignment east of the lake to protect the lake from Minnesota River flooding. Its only reservation about the eastern levee alignment is that potential use of the lake for emergency interior drainage ponding be minimized. Project impacts on the lake are addressed in the EIS supplement and appendix 4.

Preliminary cost estimates were prepared for the two levee alignments. The west alignment is approximately [illegible]0 percent more expensive. In addition, the west alignment and interior drainage would require the relocation of about 10 homes. The east alignment and interior drainage would not require any structures to be relocated.

Planning objective [illegible]* could be partially addressed by the levee alignment in the Courthouse Lake area. The east alignment would allow room for proposed expansion of the wastewater treatment facility. The west levee alignment would interfere with these plans.

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*See pages to of the main report for a discussion of the planning objectives.

Planning objectives d and h promote recreation and aesthetic values in the Courthouse Lake area. Both levee alignments would allow development of the proposed recreational trail on top of the levee and around the lake. The city could provide other day use facilities such as benches or picnic tables as desired for either levee alignment. All of these recreation facilities could be constructed with either levee alignment. However, the east levee alignment would protect these facilities from Minnesota River flooding. Silt and debris deposits, like those of past floods, would occur very infrequently with the east levee alignment.

The selection of the east levee alignment has been affirmed in this study. The above discussion indicates the east alignment is far superior to the west levee alignment.

The level of protection for flood damage prevention in urban areas is addressed by ER-1105-2-111 (draft), 28 November 1979. This Corps of Engineers regulation sets the standard project flood as the goal for high levees and rapid flow channels in urban areas. Extensive property damage and loss of life might occur if these features failed.

A standard project flood (SPF) levee plan was developed and a cost estimate prepared. This level of protection from Minnesota River flows is not economically justified. The SPF protection profile is 7 feet higher than the 100-year flood protection profile. This additional height would result in the relocation of 13 additional single family residences and require significant modification to the city's wastewater treatment plant. The SPF levee would also restrict future expansion of the treatment plant and negatively affect the aesthetics of Courthouse Lake. The SPF levee is not supported by the city of Chaska. The net benefits are maximized for a protection profile

on the order of the 100-year flood. Specific economic information is included in appendix 10 and hydrologic information in appendix 4.

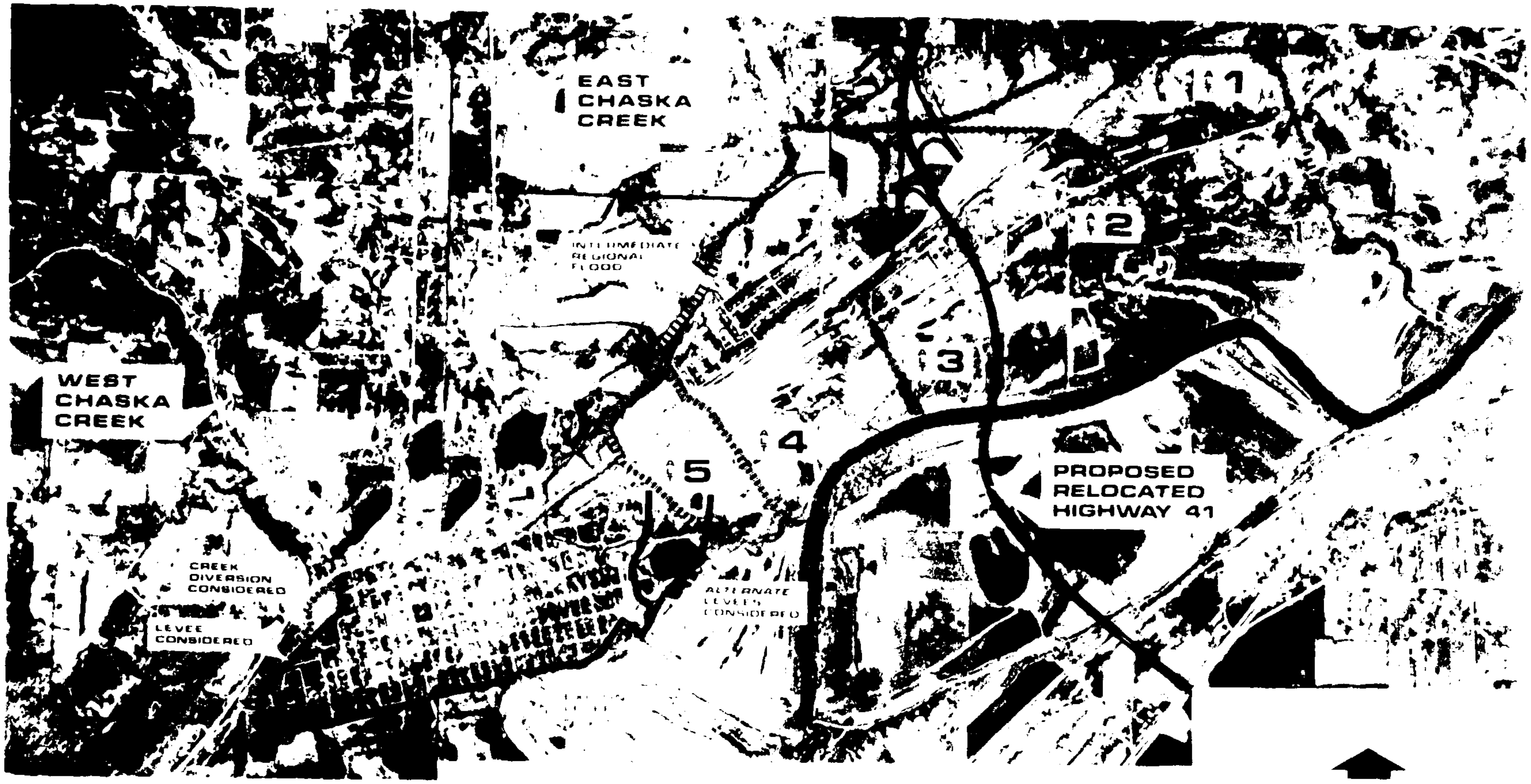
The Minnesota River rises slowly, and floods can be predicted a number of weeks in advance. In 1969, the St. Paul District helped the city add 2 feet to the existing levee prior to the flood. The city has also demonstrated the ability and determination to fight floods in the past. Therefore, it is reasonable to assume that there would be sufficient time to use emergency measures to reduce damages from floods in excess of the design flood.

EAST CREEK DIVERSION

During stage 1 coordination with Chaska officials, we became aware of the need to review some alternatives to the authorized East Creek bypass. The city expressed concern about the impacts of the authorized alignment on planned industrial development and an existing residential area. At that time it was expected that a review of the five alternative alignments (see map on page 2-4) from the feasibility study would be sufficient.

Later, during two meetings in March 1980, city officials expressed a strong interest to have a larger number of East Creek alternatives studied. The city engineer requested that we analyze two plans involving storage of East Creek runoff. City officials requested that alternative diversion alignments 1 and 2 of the feasibility report be further analyzed.

All five alternative diversion alignments were reviewed. Preliminary cost estimates and apparent environmental impacts were tabulated. Briefly, alignments 1 and 2 could potentially drain a 230-acre wetland, would require close coordination with Chanhassen for real estate interests, and could cost 30 to 40 percent more than the authorized plan. Alignments 4 and 5 would cost 20 to 30 percent more than the authorized plan and would affect the open space and aesthetic values of the park and recreation facilities along the existing channel near Valley View Boulevard. Alternative 3 was least expensive and could be slightly realigned to avoid the 230-acre wetland and minimize relocations of homes and businesses.



CHASKA, MINNESOTA
FLOOD CONTROL
IMPROVEMENTS CONSIDERED

N

1" = 400'

On the evening of 27 March 1980, a public workshop was held at Chaska. Members of the city council, the mayor, other city officials, about 40 floodplain residents, and members of a local flood control organization attended the meeting. Informal work groups assembled to discuss alternative alignments for the authorized project features and alternatives for the entire authorized project. The discussions quickly focused on the authorized East Creek bypass and alternatives to it. The groups talked about the impacts and cost estimates of the five alignments from the feasibility report (see plate 1).

Some modifications to the authorized channel alignment were mentioned Several people suggested a tunnel concept for the portion of the channel downstream of U.S. Highway 212.

As a result of the workshop, conceptual plans were formulated for several designs and minor alignment modifications of the authorized diversion channel. A concrete lined channel, large drop structures, a tunnel, and creek headwater reservoirs were developed as alternative designs for the authorized channel.

In October 1980, we received the soil boring logs for suspected foundation problem areas along the authorized bypass alignment. Lab testing of the soil samples was requested, but the information from the logs was sufficient to change part of the design of the authorized bypass. The wide and shallow authorized riprap channel below Stoughton Avenue would not be stable. This reach would need to be concrete lined, adding significant cost to the authorized project. Also, the excavation for the channel should be doubled and then backfilled with sand for stability. A preliminary cost estimate showed that this design appeared barely economically feasible, even with the cost reduction of other project features.

Because of that increased cost, the number of design possibilities for the authorized alignment was increased. We had to look more closely at the tunnel concept for the part of the authorized alignment below U.S. Highway 212. Preliminary cost estimates were prepared for a 100-year tunnel concept and several open channel designs.

In November 1980, we met with the city council members, mayor, engineer, planner, and other city employees just prior to a regular council meeting. We reviewed the preliminary tunnel and open channel plans, cost estimates, and potential impacts. The tunnel appeared to be somewhat cheaper and to minimize the negative impacts. The city officials asked us to continue the analysis of the tunnel concept along with the open channel designs.

In December 1980, the tunnel concept was refined and coordinated with the U.S. Fish and Wildlife Service and the Minnesota Department of Natural Resources (DNR) for potential environmental impacts. The authorized concrete lined channel design and several other similar channel alignments were refined. The tunnel level of protection and study items required by ER 1165-2-118, "Policies and Authorities - Federal Participation in Covered Flood Control Channels," were followed.

In January 1981, an SPF design was done for the tunnel, and other work items were planned. A meeting with North Central Division personnel was held to discuss design work done on the authorized plan.

In February 1981, preliminary cost estimates were done for five East Creek diversion plans. A standard project tunnel, a 100-year tunnel, a concrete lined channel, and a combination riprap and large drop structure plan were estimated for the portion of the East Creek diversion below U.S. Highway 212. One of the channel alignments into Chanhassen was also estimated. The following table contains the preliminary cost estimate information.

Preliminary cost estimate,
East Creek diversion designs, February 1981 ($1,000's)

Plan (1)	Direct costs	E & D	S & A	Total in & dir.	Real estate	Total
A-1	$4,141.0	$435.0	$292.0	$4,868.0	$195.0	$5,063.0
A-2	3,791.0	398.0	268.0	4,457.0	200.0	4,657.0
B-1	3,981.0	418.0	280.0	4,679.0	450.0	5,129.0
B-2	5,106.0	536.0	360.0	6,002.0	428.0	6,430.0
C	4,728.0	496.0	334.0	5,558.0	478.0	6,036.0

(1) Refer to plate 4B-38 for alignments.

CHASKA CREEK DIVERSION

This feature required only minor formulation work. The city is generally satisfied with the alignment of this feature. Design changes were made in response to a greater design discharge and new information on soil and land use. Close coordination took place with the manager of the U.S. Fish and Wildlife Refuge near Chaska because the diversion channel traverses a small portion of the refuge. Some design information reflects this coordination.

A tunnel concept was briefly analyzed. The tunnel would go from about Highway 212, under Elm Avenue for about four blocks, and exit outside the leveed area. This concept was not selected because the preliminary cost estimate showed it 10 to 20 percent higher than the authorized channel. Also, construction of the tunnel would probably require a trench in which a pipe would be laid. This would cause short-term disruption in the community during construction.

EAST CREEK INTERIOR DRAINAGE

The hydraulic analysis indicates that a large residual flooded area would remain for the East Creek terrace floodplain. The terrace area is located west of County Road 17, north of U.S. Highway 212, east of Valley View Boulevard, and south of the existing East Creek channel. See the residual floodplain plate for more detailed information. Flooding in this residual floodplain lasts for 1 hour or less and is caused by high peak interior drainage flow. The nearby bluff line of the Minnesota River valley contributes to runoff to East Creek below the proposed diversion structure, causing this brief peak flow. Flooding depths are up to 2 feet for the 100-year event and about 1.7 feet for the 20-year event.

The proposed East Creek diversion channel/tunnel would reduce the average annual flood damage by $553,000 for the terrace floodplain. However, the

average annual residual damages for the terrace floodplain are about $137,000. The conservative residual damage estimates are highly sensitive to small changes in flood depths. Using present interest rates, the $137,000 in average annual damages would support a construction first cost of $1.7 million for an additional project feature. A feature such as a low levee with appurtenant works could feasibily be constructed for about that amount. The additional first cost could be added to the project without compromising its economic feasibility. However, the additional feature is not part of the recommended plan.

Another East Creek residual floodplain for the proposed project also results from interior drainage below the proposed diversion structure. This area is located south of U.S. Highway 212 and is roughly bounded by Beech Street, Sixth Street, and the abandoned Milwaukee Railroad line.

Average annual damages without project	$11,700
Average annual damages with diversion	-7,300
Proposed project benefit	4,400

Less than 2 percent of the total East Creek average annual damage for existing conditions occurs in this area. During the 100-year event with existing conditions, 2 homes suffer first-floor flooding and 13 have basement flooding in this area. With the proposed East Creek diversion, 1 house would have first floor flooding and 12 would have basement flooding. Floodplain regulation, flood insurance, and possibly flood proofing are the only project features that could be feasible in this area. The possible benefits of $7,300 would support a project feature first cost of about $100,000, not enough to permanently relocate the homes. The main damage reduction for this area is protection from Minnesota River flooding by the proposed upgraded levee.

The following table contains information that was available for the March 1980 public planning workshop held at Chaska. This table was not changed to reflect information obtained during development of detailed plans after that meeting.

Alternative methods of managing the flood plain areas of Chaska, Minnesota

Item	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6	Plan 7	Plan 8	Plan 9	Plan 10	Plan 11	Plan 12	Plan 13	Plan 14	Plan 15
	[illegible]	Flood-plain evacuation	Flood [illegible]	Flood insurance	Flood-plain regulation	Creek diversion	Upgrade levee	Combination of plans 6 and 7	Four creek reservoirs	Four reservoirs, diversion and levee	One reservoir for each creek	Plan 11 plus levees	Creek channel improvements	Combination of plans 7 and 13	Plan 8 with city engineer's bypass alternative
Total first cost ($million)	[illegible]	38.[illegible]	[illegible]	[illegible]	[illegible]	9.5	[illegible]	16.9	[illegible]	[illegible]	[illegible]	[illegible]	11.6	[illegible]	[illegible]
Average annual cost ($1,000)	[illegible]	2,165	[illegible]	[illegible]	[illegible]	543	441	984	441	[illegible]	[illegible]	[illegible]	664	[illegible]	[illegible]
Average annual benefits ($1,000)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]80	1,023	232	1,255	414	1,255	396	1,255	496	1,255	[illegible]
Net average annual benefits ($1,000)	[illegible]	[illegible]78	-[illegible]		[illegible]	480	-209	271	-27	-[illegible]	[illegible]	[illegible]	332	[illegible]	[illegible]
Average annual damages remaining ($1,000)	1,427	[illegible]8	[illegible]8	1,427	1,427	[illegible]	1,195	172	1,012	172	[illegible]	172	[illegible]	172	172
Benefit-cost ratio	[illegible]	[illegible]	[illegible]	[illegible]	2.5	1.9	0.5	[illegible]	0.9	0.9	0.7	0.7	1.5	1.1	1.2
Federal average annual cost ($1,000)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]23	[illegible]	812	329	1,104	1,225	1,628	534	[illegible]48	
Non-Federal annual OM ($1,000)	[illegible]	[illegible]		[illegible]	[illegible]	5	25	[illegible]	35	66	35	[illegible]	7	32	
Residences relocated or purchased	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15	[illegible]	15	[illegible]	8	26	30	[illegible]
Businesses relocated or purchased		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	[illegible]	0	0	[illegible]	3	3	[illegible]
Land removed from flood plain (acres)		[illegible]	[illegible]		0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]25	345	[illegible]25	375	[illegible]	[illegible]20
Floodplain zoning used	Major	Major	Major	Major	Major	Major	Major	Some	Major	Some	Major	Some	Major	Some	Some
Cropland gained		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	-5	0	[illegible]	[illegible]
Pastureland gained		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]45	[illegible]45	[illegible]	-20	[illegible]	[illegible]	[illegible]
Increased safety of buildings	No	Slight	Slight	No	Slight	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Increased personal safety	Slight	Slight	Slight	No	Slight	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population loss from area	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Community cohesion lost	No	Yes	Yes	No	Some	No	No	No	No	No	No	No	No	No	No
Loss of tax base	None	Major	Some	None	Some	Minor	Minor	Some	Some	Minor	Minor	Minor	Minor	Minor	Some
Miles of roadway affected	0	24.0	10.[illegible]	0	0	Slight	0	Slight	[illegible]	[illegible]	2.5	[illegible]	0	0	Slight
Utility networks affected															
- Sewer lines (miles)	0	[illegible]	[illegible]	0	0	[illegible]	0.7	0.8	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	0.8
- Communication (miles)	0	[illegible]	[illegible]	0	0	0	[illegible]	[illegible]	1.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.1
- Water lines (miles)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
- Power lines (miles)	0	[illegible]	[illegible]	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Urban open space gained (acres)	0	Some	Some	0	0	-3	-2	-5	0	-5	[illegible]	[illegible]	[illegible]	-27	-5
Increase in stream erosion and sedimentation	No	No	No	No	No	No	No	No	Possibly	Possibly	Possibly	Possibly	Likely	Likely	Likely
Additional channel maintenance	No	No	No	No	No	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Temporary wetland storage (acres)	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	Yes
Reservoir water quality problems	No	No	No	No	No	No	No	No	Likely	Likely	Likely	Likely	No	No	No
[illegible] Lake water quality improved	Same	Same	Same	Same	Same	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely	Likely
Streamwater quality improved	Same	Same	Same	Same	Same	Same	Same	Same	Yes	Yes	Yes	Yes	Same	Same	
Wetland water table change	Same	Same	Same	Same	Same	Lower	Same	Lower	Higher	Higher	Higher	Higher	Same	Same	Higher
Wetlands lost (-) (acres)	0	0	0	0	0	[illegible]	-5	-9	+495(2)	+495(2)	+[illegible](2)	+[illegible](2)	[illegible]	[illegible]	-9
Low woodland lost (acres)(-)	0	0	0	0	0	-2	-5	-7	[illegible](2)	[illegible](2)	[illegible]	[illegible]	-25	-30	-5
Upland woodland lost (acres) (-)	0	0	0	0	0	-3	0	Some	-10	-13	[illegible](2)	[illegible](2)	0	0	-3

(1) Some evacuation involved.
(2) Periodically inundated.

PLAN 8

East Creek Diversion

The concept of this feature is to pass East Creek flood flows to the Minnesota River from its valley bluff line. Normal and low flows would continue down the existing creek channel. The diversion would combine 3,500 feet of open channel with a 1,500-foot tunnel. The tunnel would replace a drop structure, several road crossings, and a steep 150-foot-wide riprapped channel. The overall alignment of the channel was straightened and moved closer to County Road 17.

The diversion structure near the bluff line was moved about 800 feet downstream on East Creek for several reasons: only one mobile home would be relocated rather than six; a 230-acre wetland mentioned frequently as a public concern would no longer be subject to drainage; and planned commercial development east of County Road 17 could be accommodated. The channel would be shorter and have a flatter slope which would allow it to be grass lined. The grass lining costs less than riprap and is more aesthetically pleasing.

The tunnel would begin north of Highway 212 and exit below Riverview Terrace mobile home park. The tunnel would have no long-term impacts on existing development in contrast to the open channel design which would require relocation of 10 mobile homes. Short-term construction impacts would be reduced because no highway or railroad crossings would need to be constructed. The cost of the diversion was reduced about 10 percent. Most of this reduction was due to elimination of new highway and railroad crossings.

Construction sites and tunnel structures would be fenced for safety. Both ends of the tunnel would be closed against human trespass.

The open channel below the tunnel would be somewhat smaller than before. However, 2 acres of low mixed woodland and 2 acres of floodplain wetlands would be destroyed.

Chaska Creek Diversion

The concept of this feature is to pass Chaska Creek flows around the west end of the levee to the Minnesota River. The potential for creek flash floods to pond behind the levee is a significant interior drainage problem. The alignment and design of plan 8 are essentially the same as previously authorized. The channel cross section was changed to vertical concrete walls for about 75 percent of the length due to poor foundations. Replacement of three street bridges and one railroad bridge would be required. Construction of the three street bridges would be timed to minimize interference with local traffic patterns. The railroad bridge would require construction of a spur to allow continued rail traffic. Two single-family residences and four commercial buildings would be relocated. About seven blocks of existing urbanized creek channel would no longer carry any flows except local runoff.

Minnesota River Levee

The future without condition includes continued use of the existing city levee. The Federal project would upgrade the existing levee for 80 percent of its length to meet current design standards. About 2,000 feet of existing levee would be abandoned and about 3,700 feet of new levee would be constructed to the east of Courthouse Lake. The plan 8 version follows the exact alignment of the authorized levee.

Most of the impact of levee construction has already taken place along the existing levee. Environmental effects such as changed land use and aesthetics will not be significantly increased by the levee upgrade construction. Construction of the new levee reach is the major impact of the levee feature. About 12 acres of wetland and low woodlands combined would be lost as a result of construction of the new levee section. Two single-family residences and three garages would be relocated.

The levee alignment to the east of Courthouse Lake would be less costly than upgrading the existing levee on the west side. The new alignment would also protect a put and take trout fishery in the lake from debris, pollution and rough fish entry when the Minnesota River floods. The lake is the only trout fishery in the seven-county metropolitan area and is considered by the public to be an important recreational asset. The east levee alignment would allow room for expanding the area's wastewater treatment plant and protect the plant from Minnesota River floods. This is a significant contribution to Minnesota River water quality.

The east levee alignment allows use of a natural depression and the existing East Creek channel for interior drainage ponding. The area is already under floodplain regulations and could remain natural. Upgrading the existing levee alignment would require a pumping station, and the ponding area would relocate several single-family homes. The east alignment would minimize the negative impacts of interior drainage ponding.

Landscaping measures on the levee overburden areas adjacent to Courthouse Lake would help maintain the aesthetic appeal of the area. The lake is a popular day use area for fishermen, picnickers, and sunbathers.

Remaining Plan 8 Features

The authorized interior drainage features were reanalyzed to conform with current design criteria. Four pumping stations with a combined capacity of 223,600 gallons per minute were reduced to one pumping station with a capacity less than 10,000 gallons per minute. The cost saving was similarly significant. The reanalysis also reduced the ponding volume requirements for the East Creek channel area near Courthouse Lake. This would reduce the frequency of use of the lake for emergency ponding of interior drainage overflows from the natural depression designated for ponding. Ponding in this depression would be temporary and would not permanently damage the low woodlands present.

A residual floodplain area would exist just downstream of the East Creek diversion structure. A more complete discussion is in the formulation appendix. During Phase II studies, more detailed survey information will be used in a reanalysis of the hydraulics of this area. If the residual floodplain is unacceptable, a low levee or berm structure can be added to this plan.

The recreational trail system is exactly as authorized. The trail would contribute to the regional demand for recreational trails. No additional project land would be required for the trail. It either follows the top of the levee or an existing pathway around Courthouse Lake.

PLAN 8

East Creek Diversion

The concept of this feature is to pass East Creek flood flows to the Minnesota River without entering the area protected by the main levee. It would prevent large volumes of runoff from entering the levee interior drainage area. The without project conditions would include the existing levee maintained by the city. The existing creek combined with the existing levee has the potential to flood Courthouse Lake. A put and take trout fishery maintained by the DNR in the lake is threatened by debris, siltation, rough fish, and pollution from floods on the creek. The diversion combined with other interior drainage features would protect this resource. The diversion would also protect the open space area around the lake that is of concern to the city and the DNR.

There are open space and recreation areas owned by the city and the Lion's Club near Valley View Boulevard. These areas are in the East Creek terrace area and are considered a significant resource by the city planner and the city recreation director. The diversion would contribute significantly to flood protection of facilities and aesthetics in these areas.

The diversion channel would contribute to the protection of historic buildings and sites in the original parts of town near the levee and in the creek floodplain.

The authorized alignment was near a [illegible]-acre wetland which concerned the U.S. Fish and Wildlife Service. Soils information indicated a potential drainage of part of the wetland with the authorized alignment. The plan's alignment is farther west than the authorized plan in order to avoid potential drainage of this wetland.

The open channel below the tunnel would destroy about 2 acres of mixed low woodland and 2 acres of floodplain wetland. Landscaping measures in this area as well as the rest of the open channel would contribute to aesthetics and human enjoyment.

<u>Chaska Creek Diversion</u>

The concept of this feature is to carry Chaska Creek flows to the Minnesota River at or near the west end of the levee. This would prevent creek flows from entering the interior drainage area of the levee. The alignment and design are essentially the same as authorized. Landscaping measures and grass-lined rather than riprapped channels would contribute to aesthetics and human enjoyment. About seven blocks of existing urbanized creek channel would no longer carry creek flows. This channel reach would carry local rainfall runoff to the project interior drainage features.

The diversion would help protect historic buildings and sites located in the Chaska Creek floodplain from most potential flood damages.

About [illegible] acres of U.S. Fish and Wildlife refuge lands would be required for the downstream end of the diversion channel. This portion of the channel would accommodate the design flows at reduced velocities so they could be

carried by the existing creek channel downstream of the diversion. Plantings in this area would help reduce velocities, minimize aesthetic impacts of the diversion, and contribute to wildlife habitat. Wherever possible along both the East and Chaska Creek diversions, project lands would be planted to contribute to wildlife habitat and aesthetics affected by the diversion channels.

Minnesota River Levee and Interior Drainage

The future without project condition includes continued use and maintenance by the city of its existing levee. The proposed alignment of the project levee to the east of Courthouse Lake is an EQ measure. This would protect the trout fishery in the lake and the aesthetics and human enjoyment of the area from Minnesota River flood damage. This alignment would also protect the wastewater treatment plant and provide room for potential plant expansion. This alignment would have positive impacts on Minnesota River water quality. About 1 acre of the Courthouse Lake open area would be left unusable by a large levee raise as compared with the 100-year levee which would create about 3 acres total of open space in the lake area. The wastewater treatment plant would need to be modified with such a raise, interrupting the operation of the plant during construction. Also, some of the space needed for potential expansion of the plant would be lost.

The SPF design would require relocation of approximately 13 more single family homes and 13 more garages compared with the 100-year. The SPF total would be 15 homes and 16 garages. Many of the large backyards abutting the levee would be at least 30 percent lost to the SPF levee design. The open yards presently create a space for gardening and other human enjoyment uses. The 100-year levee would require something less than 10 percent of this open area. The view of these areas is attractive to both the landowners and the users of the informal trail along the top of the existing levee.

The proposed interior drainage plan for the East Creek channel below the diversion includes a ponding area adjacent to Courthouse Lake. The EQ consideration would be to eliminate the use of Courthouse Lake for emergency ponding of excess interior drainage. The authorized plan used the lake for emergency ponding. Not using the lake for emergency ponding would further protect the trout fishery, water quality, and open space areas of the lake.

Another authorized interior drainage feature is a culvert from the Carver County courthouse parking lot to Courthouse Lake. An EQ consideration would be to prevent parking lot runoff from entering the lake. This would further protect the lake's water quality and the trout fishery.

Landscaping of the levee and overburden areas would contribute to the aesthetics and human use of these areas. This includes the lake area and project land along the recreational trail on the levee.

PLAN B

East Creek Diversion

The concept of this feature is to divert East Creek flood flows to the Minnesota River and to prevent these flows from entering the interior drainage area of the Minnesota River levee. This feature by itself is highly cost effective because it would preclude the requirement for an extremely costly pumping station/ponding area combination for that interior drainage section. The diversion is economically justified for the flood damages it would prevent in the East Creek terrace area alone.

The authorized design was analyzed to determine whether it could be modified to reduce construction costs. The channel alignment was moved and shortened to reduce costs. The channel reach between U.S. Highway 212 and Stoughton Avenue was changed to a tunnel because of cost savings. Most of the savings reduced local share expenses because several new bridges and some real estate costs were eliminated or reduced.

Additional cost savings analysis will be done in Phase II. At that time, the most cost effective construction method and tunnel cross section will be determined. The tunnel and drop structure inlet allow the open channel portions to be designed at flatter slopes. This allows grass lining on the straight sections of the channels instead of riprap.

Chaska Creek Diversion

The concept of this feature is to divert Chaska Creek flows to the Minnesota River and to prevent those flows from entering the interior drainage area of the Minnesota River levee. The diversion is highly cost effective because it would preclude the requirement of an extremely expensive pumping station/ponding area combination for that interior drainage section.

During Phase II, the alignment and design of the vertical concrete walled channel will be completed. Between U.S. Highway 212 and Hickory Street, there is a potential to balance acquisition costs of commercial development with the additional costs of extending the concrete channel farther upstream. It may be possible to reduce the cost of the channel in this reach and reduce or eliminate relocation of the commercial development.

Minnesota River Levee

Without project conditions include the existing levee maintained by the city. It would be most economically advantageous to upgrade the existing levee rather than construct a new levee. The plan 8N levee alignment varies from the existing alignment only in the Courthouse Lake area. The plan 8N levee alignment is east of Courthouse Lake to provide adequate interior drainage ponding volume at a lower construction cost than the west levee alignment. The optimum level of protection for the levee is approximately the 115-year recurrence interval.

Significant cost savings for the authorized interior drainage features were made possible by application of current design criteria. Only one pumping station will be required in contrast to four in the authorized plan.

Culvert 2, between the Carver County Courthouse parking lot and Courthouse Lake, is not included in plan 8N. This would save approximately $20,000. It would also have a positive impact on the lake's water quality and trout fishery.

FULFILLMENT OF PLANNING OBJECTIVES

The three versions of the authorized plan - plan 8, plan 8E, and plan 8N - are compared in the following paragraphs.

PLAN 8

This plan would significantly contribute to the water quality of Courthouse Lake. This would improve use of the lake as a put and take trout fishery and contribute to the aesthetic quality of the area. The levee would prevent silt, debris, rough fish, and pollution from Minnesota River floods up to design levels from entering the lake. The East Creek diversion would prevent large volumes of creek floodwater from coming down into the interior drainage areas of the existing levee. This would prevent introduction of silt, debris, rough fish, and pollution from East Creek up to design levels. Removal of the culvert from the courthouse parking lot would also prevent pollution introduction. The combination of project features would actually isolate the lake from all surface runoff sources except the immediate banks of the lakeshore up to design levels. Information developed by the U.S. Geological Survey for this Phase I study indicates that the lake would recover in a relatively short time from emergency use of the lake for ponding interior drainage volumes above design levels.

The East Creek diversion would contribute significantly to the protection of the aesthetics, open space, and field sport facilities along

East Creek near Valley View Boulevard. Only those creek flows below 80 cfs would be allowed to pass through the diversion structure and down the existing creek channel. A residual interior drainage flood outline would cover some of these areas. However, the depths and periods of flooding would be much less than the without condition.

Plan 8 would contribute significantly to the protection of human life and property by reducing the specific flood related hazards at Chaska. The two creek diversions and the other interior drainage features would prevent flash-type ponding from occurring behind the Minnesota River levee. The levee upgrade features would provide protection from the long-term floods of the sort experienced on the Minnesota River in 1965, 1969, and other years.

The levee alignment east of Courthouse Lake would protect the wastewater treatment plant from river flooding and allow for potential expansion being studied by the Metropolitan Council. This would be a significant contribution to Minnesota River water quality. A minor contribution to water quality of the creeks and the river would result from a slight reduction in sediment loads. The channels are designed to be nonerodible. Riprap or grass would be used to line the creek channels, depending on design velocities.

The recreational trail along the top of the levee would provide a critical link in the State trail system and another system proposed by the city.

In general, Plan 8 would make a significant contribution to the publicly identified needs and planning objectives.

PLAN 8E

This plan would contribute significantly to the water quality of Courthouse Lake. Again, the levee would prevent pollution, debris, and rough fish from entering the lake. The interior drainage system and East Creek diversion

would prevent runoff ponding up to design levels. However, frequency of emergency ponding use of the lake would decrease from the 100-year to the 1,000-year recurrence interval. The culvert from the courthouse parking lot to the lake would again be removed from the design to prevent pollutants from entering the lake.

The East Creek diversion would contribute significantly to the protection of aesthetics, open space, and field sport facilities along East Creek near Valley View Boulevard. The residual interior drainage flood outline would be restricted from these areas by a berm about 4 or 5 feet high. The berm could be located to minimize aesthetic impacts, and plantings could be used to improve the appearance of the berm. The berm would provide minimal benefits and would rarely protect human life. However, these areas of human enjoyment and aesthetics would not be interrupted by flood damage.

Plan 8E would contribute significantly to the protection of human life and property by reducing the specific flood related hazards at Chaska. The two creek diversions and the other interior drainage features would prevent flash-type ponding from occurring behind the Minnesota River levee. The levee upgrade features would provide protection from the long-term floods of the sort experienced on the Minnesota River in 1965, 1969, and other years.

The levee alignment east of Courthouse Lake would protect the wastewater treatment plant from river flooding and allow for potential expansion being studied by the Metropolitan Council. This would contribute significantly to Minnesota River water quality. A minor contribution would be a slight reduction of sediment loads from the creek channels.

The recreational trail along the top of the levee and around Courthouse Lake would provide a critical link in the trail systems proposed by the city and the State DNR. This would be a significant contribution to the recreational trail needs of the Chaska area.

The landscaping measures on the levee overburden areas of Courthouse Lake would contribute significantly to the aesthetics of that side of the lake.

In general, Plan 8E would make a significant contribution to the publicly identified needs and planning objectives.

PLAN 8N

This plan would contribute significantly to the water quality of Courthouse Lake and the aesthetics of the area surrounding the lake. The two creek diversions and other interior drainage features would protect the area from creek flooding, and the levee would protect the area from river flooding.

The culvert between the courthouse parking lot and the lake would be removed to reduce costs, contributing indirectly to improved water quality of the lake.

The East Creek diversion would contribute to the open space areas, recreation facilities, and aesthetics along East Creek near Valley View Boulevard. The diversion would prevent most flood damages from East Creek. Some residual interior drainage flooding would occur in these areas, but at much lower depths and periods of flooding than the without conditions.

Plan 8N would contribute significantly to the protection of human life and property by reducing the specific flood related hazards at Chaska. The two creek diversions and the other interior drainage features would prevent flash-type ponding from occurring behind the Minnesota River levee. The levee upgrade features would provide protection from the long-term floods of the sort experienced on the Minnesota River in 1965, 1969, and other years.

The levee alignment east of Courthouse Lake would protect the wastewater treatment plant from river flooding and allow for potential expansion being studied by the Metropolitan Council. This would contribute significantly to Minnesota River water quality. A minor contribution would be a slight reduction of sediment loads from the creek diversion channels.

In general, Plan 8N would contribute significantly to the publicly identified needs and planning objectives.

SUMMARY

All three of these detailed plans are slight modifications of the authorized plan; therefore, all three would significantly contribute to the general planning objectives of this study. The plans vary on some minor features because of national objectives; however, all three plans agree on the main concepts of the planning objectives. Some of the modifications to the authorized plan address both national economic development and environmental quality components. An excellent example of this is the two creek diversions which would preclude expensive interior drainage pumping and at the same time provide flood protection for the Courthouse Lake area. It was impossible to rank these three plans on the basis of planning objective fulfillment alone. The specific evaluation criteria were required to help rank the plans.

FULFILLMENT OF SPECIFIED EVALUATION CRITERIA

The concept of the authorized plan (to upgrade the existing levee and divert the two creeks) was generally acceptable to all members of the public who were coordinated with this study. The State Planning Agency and others mentioned that they usually prefer nonstructural solutions to structural ones. However, a significant segment of the public, including city officials, supports the authorized improvements to the existing levee.

During this study, efforts were made to improve the acceptability of the various features of the authorized plan. The East Creek diversion received the most comment, but other features were also modified to improve acceptability.

The portion of the East Creek diversion north of U.S. Highway 212 was moved west, and the diversion levee was moved south. This moved the channel away from a 230-acre wetland of great concern to the U.S. Fish and Wildlife

Service, the Environmental Protection Agency, and the Minnesota Department of Natural Resources. Soil information for the area indicates that no drainage of the wetland would be expected with the modified alignment of the diversion. The new location would also interfere less with commercial development potential in the area, according to the city planner and the city engineer.

The diversion design for south of Highway 212 was also modified to make it more acceptable. Six preliminary designs were compared to the authorized diversion plan. The least expensive design, a tunnel, was also most preferred by the city. The tunnel would interfere less with existing development, including a business, about eight homes, two roads, and a railroad switchyard. Also, future potential development of the business would be less limited by the tunnel. Coordination with the U.S. Fish and Wildlife Service and the Minnesota DNR caused the tunnel location to be moved several hundred feet west. This move would decrease the impacts on floodplain wetlands at the tunnel exit and along the open channel to the river.

The East Creek diversion would avoid construction along the existing creek channel between Engler Road and Valley View Boulevard. This situation is highly desirable to the city because of the city's open space plan, aesthetics, and existing field sport facilities in the area. Construction of low levees or berms in these areas to control residual interior drainage type flows is not desirable. The levee mentioned in the EQ plan, Plan 8, to protect the field sport areas would not be acceptable.

The Chaska Creek diversion channel is acceptable to a majority of the concerned public. The U.S. Fish and Wildlife Service was concerned about the effects of construction activities in a wildlife refuge located south of the existing levee. No alternatives could be identified which completely avoided construction in the refuge. Coordination was maintained with the refuge manager in an attempt to make the diversion as acceptable as possible.

The height of the Minnesota River levee is the main concern involving the levee. Some homes and other improvements are very close to the existing

levee. Significant increases in levee height, such as 7 feet to standard project level, would be unacceptable to the city, the Metropolitan Waste Control Commission, and those interested in the Courthouse Lake area. A 7-foot levee raise would require relocation of additional homes, garages, Winkle Park, the wastewater treatment plant, and possibly several city streets as well as reducing the open space available at Courthouse Lake.

The levee alignment east of Courthouse Lake is desired by the Minnesota Department of Natural Resources and the U.S. Fish and Wildlife Service. That alignment would protect the trout fishery from river flooding. The only qualification is that ponding in Courthouse Lake from East Creek interior drainage area be reduced in frequency or eliminated, if possible. The EQ plan, Plan 8, addresses this concern.

All three detailed plans would provide a complete plan of protection for Chaska from flooding by the two creeks and the Minnesota River.

All three detailed plans would be effective in contributing to all of the planning objectives. They would all perform similarly technically because the designs are not significantly different.

Upgrading the existing levee and diverting the creeks would protect human life and property from the specific flood hazards at Chaska. The authorized levee alignment would protect the wastewater treatment plant and thereby contribute to the water quality of the river. Completely preventing interior drainage from entering Courthouse Lake may or may not be significantly better than the amount of ponding allowed by the authorized plan. The authorized trail system would significantly contribute to recreational trail needs of the study area.

The geographic scope of the study area was large enough to encompass a full understanding of the needs and problems. All three detailed plans

would be completely effective because of the extent of the study area.

Benefit-cost ratios:

Plan 8 = 1.39

Plan 8E = 1.39

Plan 8N = 1.40

The benefit-cost ratios of these three detailed plans are very similar because the differences in construction first costs for the plans are smaller than the contingency amounts for each estimate. In other words, the contingencies involved in estimating costs are greater than the differences in costs of the three plans.

It would be physically possible to reverse the construction of the features of the three plans. That is, the diversions could be filled back in and the levee could be removed, either completely or to the expected "without condition." It is doubtfull that the city would be financially capable of completely eliminating all physical traces. They could, however, effectively approach the "without condition." Development in the study area was not expected to be significantly changed by the project.

TRADE-OFF ANALYSIS

MINNESOTA RIVER LEVEE

All of the economic data and the general public preference indicate that improving the existing levee is superior to locating the levee someplace else. With existing levee upgrading, most of the impact to the community and existing improvements has aready taken place. There would also be a significant cost savings for improving the existing levee.

There are several concerns with the levee alignment in the Courthouse Lake area. Most public preference and economic data indicate the alignment

east of the lake is superior to the west alignment following the existing levee in this area. The existing alignment would reduce levee fill costs, but would require purchase of expensive real estate for interior drainage ponding and construction of an expensive pumping station. Overall, the east alignment would be less costly because of the interior drainage costs. The east alignment would also make the most significant EQ contributions. The levee would protect the trout fishery in the lake, contribute to the water quality, and create some open space for human enjoyment. The east alignment would also protect the wastewater treatment plant and allow future potential expansion of the plant. The west alignment would provide more of these benefits and would actually restrict treatment plant expansion.

CREEK DIVERSION CHANNELS

The two diversion channels are basically interior drainage features for the Minnesota River levee. The East Creek diversion would provide other benefits, such as in the East Creek terrace area. The two diversion channels together would significantly reduce the interior drainage requirements. In fact, if pumping stations and ponding areas were used instead, the project would become economically infeasible. In the absence of the diversion channel, channelization in the open space areas on East Creek would be required to protect the homes in the East Creek terrace area. The city fully supported the concept of diverting the two creeks.

PUBLIC VIEWS & RESPONSES

APPENDIX 3

LIMITED REEVALUATION REPORT

MINNESOTA RIVER AT CHASKA, MINNESOTA

PREPARED BY THE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

APPENDIX 3

PUBLIC VIEWS AND RESPONSES

TABLE OF CONTENTS

PUBLIC INVOLVEMENT PROGRAM

During initial contacts and correspondence with Chaska's mayor it was suggested that the District use the city administrator and his staff as the main contact with the city. The citizens advisory committee would be reactivated if a specific need arose. Using this information, an outline for the public involvement program was developed and coordinated with the administrator.

The public involvement outline reflects the empahsis of the particular planning tasks associated with the Corps planning stage. All four tasks of (1) problem identification (2) alternative formulation (3) impact assessment, and (4) evaluation were carried through at least one iteration in each of the Corps planning stages. The public involvement program emphasized the appropriate task during each stage of the study.

The involvement of Chaska residents in pertinent study activities relied heavily upon a base mailing list of 434 home addresses provided by the Chaska Minnesota River Flood Control Association. The association is a volunteer group of concerned Chaska citizens, the nucleus of which participated in the Corps Interim Survey Study as the citizens advisory committee. The association actively promoted and participated in the various public activities.

PUBLIC INVOLVEMENT [illegible]
CHASKA, MINNESOTA PHASE I [illegible] MEMORANDUM

[illegible] Planning Stage	"Public" Group to be Involved	Purpose of Involvement Activity	[illegible]
I	Chaska Mayor	Initiate coordination	(1) Letter (2) Briefing [illegible] (3) [illegible]
I	"All"	(1) Identify [illegible] public (2) Assess level of public interest	(1) [illegible] mailing [illegible] (2) [illegible] (3) Request [illegible]
I	Mayor and City Administrator	(1) Describe Public Involvement Program	(1) Produce [illegible] Involvement [illegible] and Administrator
I	Chaska residents and Officials	(1) Describe the Corps' planning process and where this study fits in (2) Describe the authorized project	(1) Initial Issues [illegible] report (2) [illegible] presentation (3) [illegible] details
I	"All"	(1) Identify public needs, desires and values (2) Gather information from publics concerning resources	[illegible]

PUBLIC INVOLVEMENT OUTLINE
CHASKA, MINNESOTA PHASE I - GENERAL DESIGN MEMORANDUM

Corps Planning Stage	"Public" Group to be Involved	Purpose of Involvement Activity	Public Involvement Techniques
II	City Administrator and staff	(1) Review alternatives to authorized project (2) Develop preliminary (design) alternatives for major authorized project features (3) Present social, economic and environmental implications of each alternative	(1) Planning Wor[illegible] citizens [illegible] in [illegible] activity (2) Meetings with [illegible] (3) Meetings with [illegible]
II	"All"	(1) Keep everyone informed of general study activities (2) Obtain public reaction to preliminary alternatives	(1) Progress Reports (2) Planning Workshop; city staff and Administrator included in this activity
II	City staff and Administrator	(1) Obtain general consensus on major characteristics of plan to be recommended by Corps	(1) Planning Workshop; local citizens included in this activity (2) Meetings with city staff, Administrator and Mayor
II	City Council	(1) Discuss what will happen at planning workshop	(1) Meet just prior to regular council meeting (premeet)
II	"All"	(1) Insure public participation in project formulation by interested parties	(1) Public meeting a. authorized project b. alternatives from survey report (2) Ask public for views concerning available alaternatives (3) Review public comments and make modifications as needed

PUBLIC INVOLVEMENT OUTLINE
CHASKA, MINNESOTA PHASE I - GENERAL DESIGN MEMORANDUM

Corps Planning Stage	"Public" Group to be Involved	Purpose of Involvement Activity	Public Involvement Techniques
III	"All"	(1) Present specific details of plan selected (2) Record all specific issues by public	(1) Formal public meeting comments on proposed plan (2) Distribute written re[illegible] of meeting
III	City Staff	Present proposed project	(1) Meeting at City Hall (2) Receive and consider comments
III	City Council	Present proposed project and discuss what will happen at the formal public meeting	Meet just prior to regular council meeting (premeet[illegible]
III	City Staff	Review Draft Phase I GDM	Receive and consider [illegible]

LIST OF PUBLIC INVOLVEMENT ITEMS

Study Initiation Notice, December 1978

Public Responses to Initiation Notice

Public Comments on September 1979 Draft PoS

Invitation for Slide Presentation to Organizations

Progress Report, September 1979

Progress Report, December 1979

Newspaper Article Concerning Second Progress Report

MFR - Meeting with City Concerning East Creek Diversion Alternatives

Progress Report, March 1980

Planning Workshop Handout, March 1980

Progress Report, April 1980

Letter From Minnesota DNR Stating Concern and Support

MFR - Meeting with City Concerning Detailed Design - Plan 8

Public Meeting Notice, May 1981

Newspaper Article Concerning Public Meeting

Transcript of May 1981 Public Meeting

Letter of Support from Chaska's Mayor Swanson

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:
NCSED-PB

[illegible]

This is to advise you of our current studies concerning improvements for flood damage reduction on the Minnesota River, East Creek and Chaska Creek at Chaska, Minnesota. The project was authorized by the Water Resources Development Act of 1976 (Public Law 94-587).

Funds were appropriated by Congress this fiscal year to initiate the Phase I General Design Memorandum stage of preconstruction planning. Phase I investigations are limited to studies necessary to insure that the authorized plan or a modification reflects current public desires and meets current standards for national economic efficiency, environmental quality, regional development, and social well-being. Any departures from the authorized plan must be fully documented and justified in the Phase I General Design Memorandum. Upon approval of the Phase I General Design Memorandum by the Chief of Engineers, we will proceed with detailed designs for specific features of the project insofar as available funds permit. A description of the authorized plan and a project map are inclosed.

Throughout the study, special coordination will be maintained with local, State, and Federal agencies and groups. They will be requested to furnish views, assist in assessing impacts on existing resources, and contribute to the reevaluation of alternatives.

NCSED-PB 15 December 1978

The first step in our Phase I investigation will be development of a plan of study to define problem areas, available data, study needs, scope of work required, study procedure, and work schedule. To insure that our planning is as complete as possible and permits full participation by all interests, we would appreciate receiving your current views, comments, and recommendations on the authorized project. In addition, we would appreciate receiving the following:

a. A list of general and specific problem areas that you consider important in this study, with an indication of the relative importance of each.

b. A description of studies you believe are necessary to insure that the authorized plan or a modification reflects current public desires and current formulation and evaluation criteria.

c. An indication of your agency's interest and capability to participate in the Phase I General Design Memorandum and subsequent investigations.

d. The name and telephone number of a person in your agency with whom we can coordinate all aspects of this study to insure that your interests are adequately considered.

We would appreciate receiving this information by 5 January 1979. If you need further information or have any questions, please contact me. Mr. David J. Haumersen, Chief of our Advance Planning Section (612-72 -7576) can provide additional details.

Sincerely,

FORREST T. GAY, III
Colonel, Corps of Engineers
District Engineer

2 Incl
As stated

Identical letter to:
(see attached list)

NCSED-PB 15 December 1978

Identical letter to:

Mr. Erling Weiberg
Executive Secretary
Minnesota Water Resources Board
555 Wabasha - Room 206
St. Paul, Minnesota 55102

Mr. Peter L. Vanderpoel
Director, Minnesota State
Planning Agency
101 Capitol Square Building
550 Cedar Street
St. Paul, Minnesota 55101

Mr. John E. Boland
Chairman, Metropolitan Council
300 Metro Square Building
Seventh and Robert Streets
St. Paul, Minnesota 55101

Dr. Richard Wade
Director
Division of Environmental Health
Minnesota Department of Health
717 Delaware Street SE
Minneapolis, Minnesota 55440

Mr. Charles Kenow
Environmental Quality Council
100 Capitol Square Building
550 Cedar Street
St. Paul, Minnesota 55101

Ms. Liza Nagle
Environmental Assessment Officer
Minnesota Historical Society
Building 25
Fort Snelling
St. Paul, Minnesota 55111

Mr. Richard E. Friedman
Regional Director, Region V
Public Health Service
U.S. Department of Health, Education
and Welfare
300 South Wacker Drive
Chicago, Illinois 60606

Mr. E. C. Balke
Regional Hydrologist, Central Region
National Weather Service
601 East 12th Street - Room 1836
Kansas City, Missouri 64106

(Copy to:
Mr. John V. Graff
Supervisory Meteorologist
National Weather Service
U.S. Department of Commerce
Federal Aviation Building
6301 34th Avenue South
Minneapolis, Minnesota 55450)

Mr. Donald R. Albin
District Chief
U.S. Geological Survey
702 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Mr. Neil S. Haugerud
Chairman, Upper Mississippi River
Basin Commission
510 Federal Building
Fort Snelling
Twin Cities, Minnesota 55111

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-PB

'5 September 1979

Many people in Chaska are concerned about the potential danger of flooding in the community. The Chaska City Administrator has told us that you may be one of those who are interested in finding out what is being done to provide a permanent solution to Chaska's flood problem.

In cooperation with the city and other government agencies, the Corps of Engineers is reviewing the flood problems in Chaska. We would like to offer you, and the organization you represent, an opportunity to view a slide presentation we have prepared and to ask questions about the Corps of Engineers study. A public showing of the slide presentation has already been tentatively scheduled for a planning commission meeting to be held on 18 October 1979. However, at your request, we will schedule a showing and a question and answer period for your organization. If you would like to arrange a meeting or if you have any questions, please contact us. Mr. Herb Nelson (725-7472) is the Corps study manager.

We also plan to publish a series of progress reports which will be mailed periodically to interested people. These reports will be two or three pages long and will help keep you informed of study progress. Your name is already on our mailing list. If you know of anyone else who is interested, please invite him or her to contact Mr. Nelson.

Sincerely,

J R Calton

J. R. CALTON
Chief, Planning Branch
Engineering Division

Identical letters to:
see attached list

CITY OF CHASKA
MAILING LIST FOR
CREEK DIVERSION INFORMATION

Ms. Marjory Adams
Federated Women's League
112333 Chatfield Court
Chaska, Minnesota 55318

Ms. Penny Eastlund
League of Women Voters
1491 Crest Drive
Chaska, Minnesota 55318

Mr. Jim Worm
Fire Chief
311 Maple Street
Chaska, Minnesota 55318

Mr. Karl Nyline
Rotary Club
1260 Stephen Lane
Chaska, Minnesota 55318

Mr. Bill Jaffa
Chaska Chamber of Commerce
P.O. Box 55
Chaska, Minnesota 55318

Mr. Steve Ward
Jaycees
36 Judith Drive
Brankdondale Mobile Home Pard
Chaska, Minnesota 55318

Mr. Kelly Hanson
American Legion
North Victoria Drive
Victoria, Minnesota 55386

Mr. Bernie Kerber
V. F. W. Auxiliary
407 Cedar Street
Chaska, Minnesota 55318

Mr. William Paal
V. F. W.
312 Hickory Street
Chaska, Minnesota 55318

Pat Kovaleski
Senior Citizens
Lake View Terrace
Waconia, Minnesota 55387

Ms. Karen Hyde
Jonathan Association
Lake Village Center
Chaska, Minnesota 55318

Mr. Roger Amundson
School Board
246 Highland Drive
Chaska, Minnesota 55318

Mr. Mike Young
Lion's
P.O. Box 67
Chaska, Minnesota 55318

Ms. Luella Schmitt
410 West Second Street
Chaska, Minnesota 55318

Mr. Cy Ess
115 South Elm Street
Chaska, Minnesota 55318

Mr. C. A. Lubansky
315 East Third Street
Chaska, Minnesota 55318

Ms. Elanor Behrns
316 East Second Street
Chaska, Minnesota 55318

Mr. Randy Christianson
500 Beech Street
Chaska, Minnesota 55318

Mr. Wilbert Kelm
601 West First Street
Chaska, Minnesota 53318

RESPONSES TO THE JANUARY 1979 PHASE I STUDY INITIATION NOTICE

On 15 December 1978, the St. Paul District issued a Phase I general design memorandum study initiation letter. The following agencies sent comments on the study in response to the initiation letters:

U.S. Department of the Interior, Fish and Wildlife Service
U.S. Department of the Interior, Geological Survey
U.S. Environmental Protection Agency
U.S. Department of Commerce, National Oceanic and Atmospheric Administration
U.S. Department of Transportation
U.S. Department of Housing and Urban Development
Minnesota Department of Natural Resources
Minnesota State Planning Agency
Minnesota State Archeologist
Metropolitan Countil
Carver County

Copies of the letters are shown here.

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL MINNESOTA 55101

REPLY TO
ATTENTION OF:
NCSED-PB

15 December 1978

This is to advise you of our current studies concerning improvements for flood damage reduction on the Minnesota River, East Creek and Chaska Creek at Chaska, Minnesota. The project was authorized by the Water Resources Development Act of 1976 (Public Law 94-587).

Funds were appropriated by Congress this fiscal year to initiate the Phase I General Design Memorandum stage of preconstruction planning. Phase I investigations are limited to studies necessary to insure that the authorized plan or a modification reflects current public desires and meets current standards for national economic efficiency, environmental quality, regional development, and social well-being. Any departures from the authorized plan must be fully documented and justified in the Phase I General Design Memorandum. Upon approval of the Phase I General Design Memorandum by the Chief of Engineers, we will proceed with detailed designs for specific features of the project insofar as available funds permit. A description of the authorized plan and a project map are inclosed.

Throughout the study, special coordination will be maintained with local, State, and Federal agencies and groups. They will be requested to furnish views, assist in assessing impacts on existing resources, and contribute to the reevaluation of alternatives. Comments from your agency on our previous study were included in our August 1973 feasibility report. A copy of your letter furnishing comments is inclosed.

NCSED-PB | 1[illegible] December 197[illegible]

The first step in our Phase I investigation will be development of a plan of study to define problem areas, available data, study needs, [illegible] of work required, study procedure, and work schedule. To insure that our planning is as complete as possible and permits full participation by all interests, we would appreciate receiving your current views, comments, and recommendations on the authorized project. In addition, we would appreciate receiving the following:

a. A list of general and specific problem areas that you consider important in this study, with an indication of the relative importance of each.

b. A description of studies you believe are necessary to insure that the authorized plan or a modification reflects current public desires and current formulation and evaluation criteria.

c. An indication of your agency's interest and capability to participate in the Phase I General Design Memorandum and subsequent investigations.

d. The name and telephone number of a person in your agency with whom we can coordinate all aspects of this study to insure that your interests are adequately considered.

We would appreciate receiving this information by [illegible] January 197[illegible]. If you need further information or have any questions, please contact us. Mr. David I. Haumersen, Chief of our Advance Planning Section ([illegible]-7576) can provide additional details.

Sincerely,

Forrest T. Gay, III

FORREST T. GAY, III
Colonel, Corps of Engineers
District Engineer

2 Incl
As stated

2

NCSED-PE 15 December 1978

Identical letter to:

Mr. Ronald Gatton
Regional Administrator, Region V
Federal Housing Administration
300 South Wacker Drive
Chicago, Illinois 60606

Mr. Harry M. Major
State Conservationist
Soil Conservation Service
200 Federal Building
316 North Robert Street
St. Paul, Minnesota 55101

Mr. John D. Cherry
Regional Director
Lake Central Region
Heritage Conservation and Recreation Service
Federal Building
Ann Arbor, Michigan 48107

Mr. Charles A. Hughlett
Acting Regional Director
U.S. Fish and Wildlife Service
Federal Building - Fort Snelling
Twin Cities, Minnesota 55111

Mr. John McGuire
Acting Regional Administrator
Region V
U.S. Environmental Protection Agency
230 South Dearborn Street
Chicago, Illinois 60604

(Copy to:

Mr. Clarence C. Oster
Director, Western District Office
U.S. Environmental Protection Agency
7401 Lyndale Avenue South
Minneapolis, Minnesota 55423

Mr. E. Dean Carlson
Division Engineer
Federal Highway Administration
Metro Square Building - Suite 490
St. Paul, Minnesota 55101

Ms. Sandra S. Gardebring
Executive Director
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113

Mr. Joseph Alexander
Acting Commissioner
Minnesota Department of Natural Resources
Centennial Building - Third Floor
St. Paul, Minnesota 55155

Dr. Elden Johnson
Minnesota State Archeologist
Department of Anthropology
University of Minnesota
215 Ford Hall
Minneapolis, Minnesota 55455

Chicago-Milwaukee Corporation
516 West Jackson Boulevard
Chicago, Illinois 60606

Mr. Bernard Harrington
Chief Engineer
Metropolitan Waste Control Commission
350 Metro Square Building
Seventh and Robert Streets
St. Paul, Minnesota 55101

Honorable Tracy Swanson
Mayor of Chaska
205 East Fourth Street
Chaska, Minnesota 55318

Mr. F. C. Marshall
Assistant Commissioner
Minnesota Department of Transportation
413 Transportation Building
John Ireland Boulevard
St. Paul, Minnesota 55155

Mr. Patrick Murphy
Director of Public Works
Carver County
Chaska, Minnesota 55318

United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO

St. Paul Field Office, Ecological Services
538 Federal Building and U.S. Court House
316 North Robert Street
St. Paul, Minnesota 55101

Colonel Forrest T. Gay, III
District Engineer
U.S. Army Corps of Engineers
St. Paul District
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

Thank you for your letter advising us that the Corps of Engineers is initiating Phase I planning for flood damage reduction at Chaska, Minnesota.

We have made a preliminary review of the project's concepts and offer the following with respect to the plan's needs.

1. The plan should address the concerns presented in our letter of October 31, 1973.

2. The plan should include alternatives that avoid conducting proposed construction activities on the Minnesota Valley National Wildlife Refuge. The refuge land in question is immediately south of the levee section that lies between the city and Chaska Creek. It appears from plate 3 that approximately 800 feet of the proposed diversion channel for Chaska Creek will fall within the refuge boundaries.

3. The plan should address the physical and biological impacts of the overall project to all floodplain wetlands within the project's boundaries, and the project's conformance with Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands).

4. The plan should describe the acute and chronic effects of the temporary ponding of flood waters on the Courthouse Lake wetland complex, to include the impacts to wetland hydrology, biological productivity, sedimentation, etc.

5. The effects of the East Creek flood bypass on sediment loading in the Minnesota River and existing East Creek floodplain wetlands should be analyzed.

The items listed above are not ranked as to our preception of their relative importance. All are issues vital to our review of the project.

Mr. Gary Wege (725-7131) will be coordinating our involvement with the Chaska project.

Sincerely,

Richard F. Berry

Richard F. Berry
Field Office Supervisor

cc: U.S. EPA, Chicago, IL

United States Department of the Interior

GEOLOGICAL SURVEY

702 Post Office Building
St. Paul, Minnesota 55101
January 4, 1979

Col. Forrest T. Gay III
District Engineer
St. Paul District
Corps of Engineers
Room 1135 Post Office Building
St. Paul, Minnesota 55101

Attn: NCSED-PB

Dear Col. Gay:

We received your letter of 15 December 1978 concerning studies of flood-damage reduction on the Minnesota River, East Creek, and Chaska Creek at Chaska, Minnesota. The U.S. Geological Survey will furnish any information from our files or ongoing work that might aid the study. If [illegible], we would be happy to discuss Survey participation in hydrologic or hydraulic aspects of the phase I study.

Mr. George H. Carlson of this office will serve as the contact for coordination of Survey activities in the project.

Sincerely yours,

Donald R. Albin

Donald R. Albin
District Chief

cc: Reg Hyd, WRD, NR, Reston

[illegible]

JAN 1 [illegible]

Colonel Forrest T. Gay, III
District Engineer
U.S. Army Engineer District, St. Paul
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

We appreciate your letter of December 15, 1978, in regard to the further studies for flood damage reduction on the Minnesota River, East Creek and Chaska Creek at Chaska, Minnesota. Your letter requested our views on the proposed flood control plans. We have previously commented on the Draft and Final EIS. These letters expressed our concerns for the protection of wetlands in the project area and the maintenance of water quality.

The flood control plans indicate that one of the diversion channels would pass near a 23[illegible]-acre wetland area. The General Design Memorandum should address the quantity and quality of wetlands that could be adversely impacted or lost as a result of the flood control plans. Alternative designs which would avoid adverse wetland impacts should be evaluated.

Part of the flood control project uses Courthouse Lake as a ponding area for excess flows. Information should be provided to indicate what water quality changes will result from the ponding of water in this area. The discussion should provide information on the impacts upon dissolved oxygen and whether or not the oxygen sag will be transferred further downstream. If the oxygen sag is transferred further downstream, the impacts upon downstream users should be assessed.

Other questions which we raised during our review of the Draft and Final EIS's were in regard to the disposal sites for excess earthern material, the land use plan for the community and induced development caused by the project. These questions still need to be addressed. We are pleased to see the community has adopted flood plain management regulations. These regulations need to be described in the GDM. The potential for changes in the flood plain, and increased stormwater runoff as development increases in the study area, should be noted. It should be explained how plans for maintaining water quality will take such future situations into consideration.

Please contact Mr. William Franz of our Environmental Impact Review Staff at 312-353-2307, if you have any questions regarding our comments and to coordinate future actions on this proposal.

If a site visit to the area is planned during the next several months, please advise us accordingly.

Sincerely,

Ronald L. Mustard

Ronald L. Mustard, Director
Office of Federal Activities

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE
River Forecast Center
Room 1715A, 601 E. 12th Street
Kansas City, MO 64106

December 29, 1978

Colonel Forest T. Gay, III
District Engineer
St. Paul District
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

Your letter of 15 December to Mr. E.C. Balke, Regional Hydrologist, National Weather Service (NWS) Central Region was referred to me for reply. The subject concerns your studies for improvements to reduce flood damages in the lower reaches of the Minnesota River, the project authorized by P.L. 94-587.

Mr. Balke is retiring from the Federal Service 13 January and present indications are that the responsibilities of my current position as Hydrologist in Charge of the River Forecast Center (RFC), a field office, will be augmented by those of the Regional Hydrologist's office which are staff functions in service to the Regional Director, NWS Central Region. My Deputies will most probably be Mr. Russell G. Mann for Regional staff functions (FTS 758-3229) and Dr. Lee W. Larson (FTS 758-2041) for RFC line functions. I can be reached at either of those numbers.

In addition, as you are no doubt already aware, a new NWS RFC has been authorized. Initial steps have been taken for its establishment in Minneapolis and the effort to select its Hydrologist in Charge. Minnesota River interests currently receive their hydrologic forecast support from the Kansas City RFC, via the NWS Forecast Office (NWSFO) in Minneapolis, of which Mr. John Graff is the Meteorologist in Charge. The first echelon hydrologic service responsibility for the Minnesota River will be transferred to the new Minneapolis RFC when it is able to accept it, currently targeted for 1980. Requirements for Meteorological forecasts and data, as well as flash flood watch, warning and second echelon hydrologic service support can be fulfilled from the NWSFO. That office manages hydrologic data acquisition and forecast dissemination activities in its area.

The above outline is for both informational purposes and in response to the request of paragraph d., of your letter. In response to your other requests, the NWS direct interests in projects of this nature are hydrologic rather than structural. If we can be of assistance, we would welcome the opportunity to review, and where appropriate, comment on hydrologic aspects of the study as it develops. Also, as you know this agency is responsible for river forecasts and flood warnings, not only for the Minnesota River, but all other tributaries to the Mississippi River and the mainstem itself. As you recall, you and I had recent occasion to coordinate our respective operational field responsibilities of this nature prior to, and during the 1978 record, spring snowmelt floods in the Red River Valley.

Accordingly, it is essential that we are made aware of any structural impacts on realtime, operational stream flow and stage forecasting in affected reaches. These would take the form of: rating curves of both a design and actual nature, the latter at significant construction phases; plans of operation of particular containment and diversion structures; appropriate Operations Manuals, etc.

If we can be of further service please contact us as appropriate to your needs, either directly or to the particular office in Minneapolis, the WSFO or the RFC, following establishment of the latter, and of which you will be kept advised.

Sincerely,

Herman F. Mondschein
Hydroloigst-in-Charge

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION 5
Suite 490, Metro Square Building
St. Paul, Minnesota 55101

January 24, 1979

IN REPLY REFER TO

Colonel Forrest T. Gay, III
District Engineer
Department of the Army
St. Paul, District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minn. 55101

Dear Colonel Gay:

Thank you for the opportunity provided by your letter of December 15, 1978 to comment on proposed improvements for flood damage reduction on the Minnesota River, East Creek and Chaska Creek at Chaska, Minnesota. We have no substantive comments to offer beyond those expressed by our May 31, 1973 letter.

We are pleased to note that you will coordinate design with effected local highway agencies and the Minnesota Department of Transportation (MN/DOT). These agencies will be able to assist the Corps in applying appropriate design standards for effected highway structures. and may therefore be of help in preparation of the Phase I General Design Memorandum.

Interests of the Federal Highway Administration will be insured through your coordination with MN/DOT, Carver County, and Chaska to allow their input regarding impact to highway structures. We will also appreciate continued receipt of documents appraising FHWA of progress on the Chaska project as it may effect future Federal-aid highway projects.

Sincerely yours,

E. Dean Carlson
Division Administrator

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
AREA OFFICE
6400 FRANCE AVENUE SOUTH
MINNEAPOLIS, MINNESOTA 55435

REGION V
300 [illegible]
Chicago, [illegible]

January 18, 1979

IN REPLY REFER TO:

5.6SS:WM

David J. Haumersen, Chief,
Advance Planning, Department of the Army
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Customs House
St. Paul, Minnesota 55101

Dear Mr. Haumersen:

Subject: Flood Damage Reduction Studies,
Bassett Creek, Minnesota River,
East Creek and Chaska Creek

Thank you for the informational requests concerning the above. At this time, the HUD Area Office cannot offer any comments or recommendations relative to these proposed studies. If there are specific questions, please call William [illegible], Environmental Clearance Officer, at 725-4724. We appreciate the opportunity to participate in these studies.

Sincerely,

for C. C. Ewing

Thomas T. Feeney
Area Manager

DEPARTMENT OF NATURAL RESOURCES
CENTENNIAL OFFICE BUILDING · ST PAUL, MINNESOTA · 55155

DNR INFORMATION
(612) 296-6157

December 29, 1978

Colonel Forrest T. Gay, III
District Engineer, St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Gay:

SUBJECT: FLOOD DAMAGE REDUCTION STUDIES - CHASKA, MINNESOTA

We are pleased to learn that Congress has approved further efforts for flood damage reduction in Chaska, Minnesota. In response to your request, we are providing the following comments:

GENERAL AND SPECIFIC PROBLEM AREAS

1. Emergency Levee

The existing emergency levee gives the residents of Chaska a false sense of security since many believe that the levee provides total protection from flooding. In terms of public awareness of the true flooding threat, the emergency levee may actually be a hindrance to the resident's perception.

The presence of the emergency levee also has the potential to increase flood damages because there are not adequate provisions to handle internal drainages. This could be a critical problem in light of the large drainage areas of the tributary creeks.

2. Land Use Controls

Lands "protected" by the emergency levee and lands which are not "protected" are both subject to the same flood plain management provisions. This poses administrative problems for the City when dealing with building improvements and additions.

3. Future Urbanization

It is likely that Chaska will continue urban expansion. The increased rates and volumes of runoff will result in greater flood damage potential, particularly on the tributary creeks.

December 29, 1978

NECESSARY STUDIES

1. Structural and hydraulic characteristics of the emergency levee must be evaluated. This would include an evaluation of the upstream impacts of the existing levee on flood levels, an evaluation of hydrologic conditions contributing to internal drainage problems and the cost and location of new/modified levees.

2. Study of the impacts of urban expansion in the tributary watershed and the development of a viable plan for storage and retention of urban runoff. This plan should ensure that downstream flood damages are not increased and, if possible, promote decreases in these damages.

3. Once a project plan is formulated, it will be necessary to define and map the resulting flood plain, floodway and flood fringe. This would enable the City to continue to administer land use controls which are consistent with the state and FIA regulations.

4. Since the issuance of Executive Order 11988 and the subsequent federal interest in hazard mitigation, it would be appropriate and desirable to reevaluate relocation and flood proofing as a viable alternative.

5. A necessary part of the project planning process would be the development and implementation of an effective flood warning system. This would have the effect of providing some degree of protection prior to the implementation of the final project and would complement the final project.

6. The City, County, Division of Emergency Services, DNR and National Weather Service should all participate in the development of the flood warning system.

7. The bypass channel extends to the Minnesota River with the potential for impacting river bottom wetlands. Detailed analyses of these impacts would be appropriate.

8. The Minnesota Department of Transportation has plans to provide a new crossing of the Minnesota River. Since this crossing may be within the study area, the plan of the MDOT should be coordinated to ensure plan compatibility.

The main contact for this study will be Kent Lokkesmoe, Regional Hydrologist, Metro Region, Department of Natural Resources, 1200 Warner Road, St. Paul, Minnesota 55106 (612-296-7523). It is the intent of the Department to be actively involved in the Chaska Study process at all stages. We will be available to provide guidance and direction which are consistent with the various program objectives of the State of Minnesota.

We look forward to continued cooperation in this matter.

Yours truly,

Joseph N. Alexander
Acting Commissioner

cc: Kent Lokkesmoe

[illegible] T. Gay, III
[illegible] Corps of Engineers
[illegible]

[illegible]

1. [illegible]
2. [illegible] diversion [illegible] Creek, [illegible] potential [illegible] hazards, [illegible] Minnesota River [illegible];
3. Impact of construction of diversion channel on fish and wildlife habitat [illegible];
4. Alternatives to diversion channel construction on both creeks;
5. Alternatives to the entire flood protection project, including [illegible] relocation; and
6. Impacts of the project on regional flood levels.
7. What is the impact of this project on the Minnesota River Federal Wildlife Refuge?

This agency is not interested in actively participating in the Phase I General Design Memorandum investigation. We would, however, like to review the Plan of Study when completed.

Thank you for the opportunity to review and comment on the proposed Chaska Flood Protection Project.

Sincerely,

Clifton J. Aichinger

Clifton J. Aichinger
Critical Areas Coordinator

CJA:bcl

survey including sub-surface [illegible]

Areas that should be surveyed [illegible] include:

1) the entire length of the [illegible] Creek [illegible]
2) the entire length of the [illegible] Creek diversion
3) [illegible]

[illegible] be placed along the leve[illegible]

4) the total area of ponding around Courthouse Lake
5) any additional areas where fill would be obtained for the project

It is possible that some of these areas are already highly disturbed. This can be ascertained by an archaeologist in the field, and at [illegible] than [illegible].

Recommendations for the final location of project [illegible] should be evaluated in light of the findings of the archaeologist conducting the survey. If the presently known historic sites mentioned above are not located through standard survey procedures, the possibility of the existence of deeply buried cultural horizons should be examined. If such deposits exist, an archaeologist should be present during all excavations.

Thank you for this opportunity to comment on the environmental impact of of the Chaska Flood Control Project. If we may supply any further information on the procedures outlined above, please contact us.

Sincerely,

Christy A. H. Caine
State Archaeologist

cc: Russell Fridley
State Historic Preservation Office

[illegible] COUNCIL OF THE TWIN CITIES AREA

[illegible] Building, 7th Street and Robert Street, Saint Paul, Minnesota 55101 Area 612, 22[illegible]

January 10, 1979

District Chief
St. Paul District - Corps
of Engineers
Department of the Army
1135 U.S. Post Office and
Custom House
St. Paul, Minnesota 55101

Attention of: NCSED-PB

Dear Sir:

This is in response to your notice of studies of improvements for flood damage reduction on the Minnesota River, East Creek and Chaska Creek, at Chaska, Minnesota. As you requested we are providing information for these improvements studies.

First of all, population projections for the two small watersheds contained in the [illegible] Feasibility Report for Flood Control Minnesota River at Chaska are no longer accurate. The document reports an expected population of over 50,000 in the year 2000. Because of various unforeseen conditions, development [illegible] the Chaska Creek and East Creek (Hazeltine-Bavaria Creek) Watershed will be far less than was projected in the late sixties and early seventies. Present Metropolitan Council's population projections for the year 2000 are as follows:

City of Chaska	22,500
Township of Chaska	180
Township of Dahlgren	1,500

Under the Metropolitan Land Planning Act, each municipality is required to prepare a local plan which must be consistent with the level of metropolitan services available or planned for by the Metropolitan Council. These changes in population should be translated into lower demand for urban development [illegible] [illegible] effect on the [illegible].

Second, the proposed plan does not appear to require municipalities included in

[illegible]
District - Corps of Engineers
[illegible], 1979

the watersheds to provide for the proper management of stormwater. A recent study of planning for stormwater in the Metropolitan Area points to the City of Chaska having no stormwater management plan. It would seem that stormwater management should be an integral part of the solution to flooding problems. This would be consistent with the Metropolitan Council's philosophy and policies.

Third, existing Metropolitan Council water resources policies favor the use of non-structural solutions to the extent possible. The Council's attitude is to encourage the use of existing natural drainage features, as much as possible, together with adequate land use planning to prevent or limit flooding problems. A copy of the Council's Water Resources Guide Chapter is enclosed for your information. The proposed plan does not appear to include non-structural measures to provide a solution to the problems.

We have two additional concerns for your consideration, one regarding highways, the other the Chaska waste treatment plant. There are plans for the upgrading of highways TH 212 and TH 41 principal arterial level but no new locations. The new routes are not yet scheduled for construction. The two existing roadways for 212 and 41 would be retained as minor arterials or collectors at their existing locations. Any solutions to the flooding problems should be compatible with the proposed, as well as the existing highways. A map of the proposed highways is attached for your information.

The Metropolitan Council's plan for waste management provide for the retention and potentially the expansion of the Chaska wastewater treatment plant. The Council is concerned about the adequacy of the flood control system to protect the plant and any future expansion, as well as the need for the system to allow for the expansion of the plant beyond the present capacity.

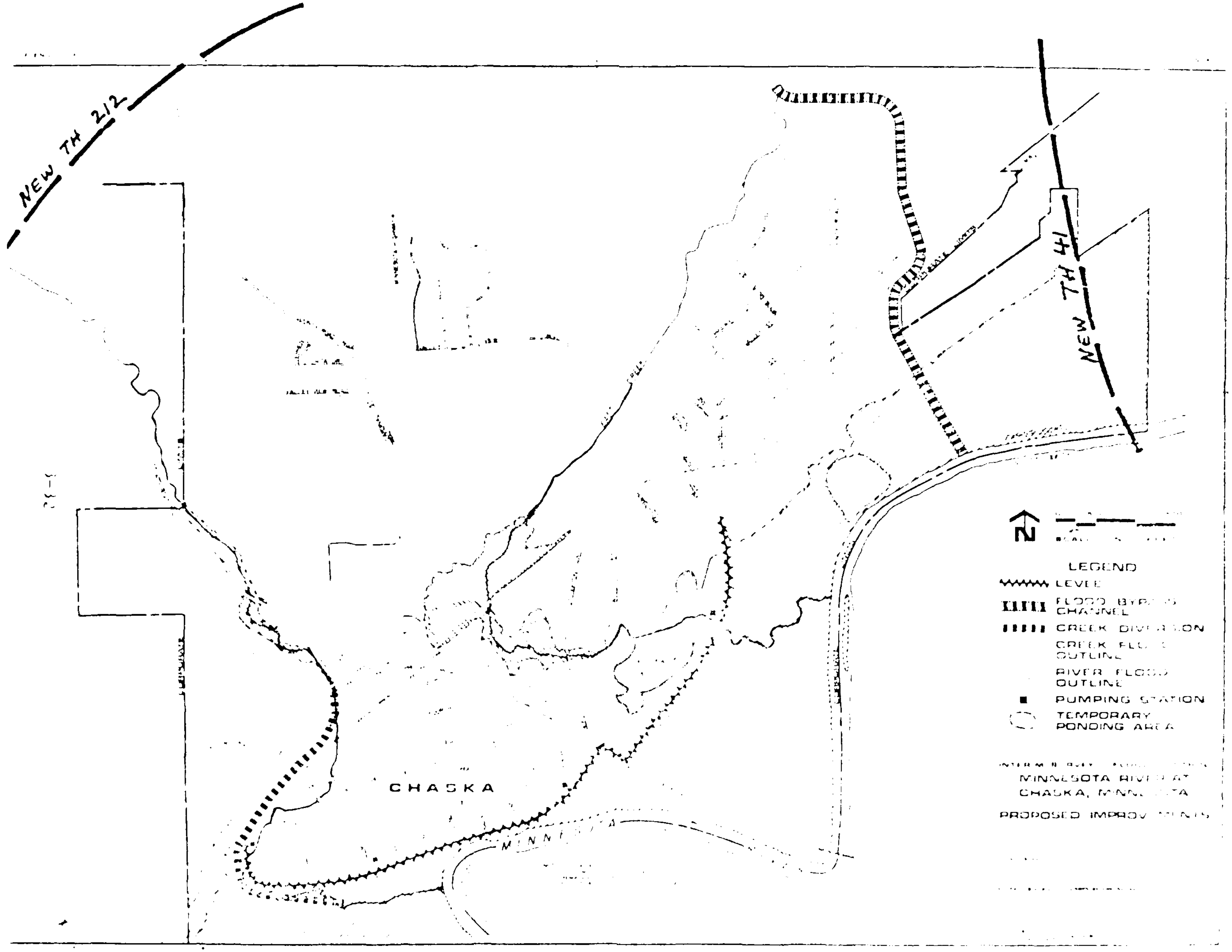
We have designated Mr. Marcel Jouseau of our staff for future contacts with the Council on this project. Please feel free to contact Mr. Jouseau at 291-6402.

Thank you for the opportunity to provide comments on this project.

Yours sincerely,

Eugene E. Franchett,
Director, Physical Planning
and Development Department

EEF/cj
Enclosures


NEW TH 212
NEW TH 41
LEGEND
LEVEE
CHANNEL
CREEK DIVER
RIVER FLOOD
OUTLINE
PUMPING STATION
TEMPORARY
PONDING AREA
CHASKA
PROPOSED IMPROV

CARVER COUNTY [illegible]
[illegible]
CHASKA, MINNESOTA [illegible]

COUNTY OF CARVER

January [illegible], 1979

U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

RE: [illegible]-PB

Dear Colonel [illegible]:

Your letter of December 1[illegible], 1978 informed us of your current study regarding flood damage reduction in the City of Chaska. Your letter also requested comments as well as a contact person within our organization.

We have no comments at this time other than to make reference to our letter and resolution of June [illegible]. We are interested in being informed as your study progresses, particularly as it may affect county highways and the courthouse [illegible].

For coordination, please use myself and Don [illegible], Chief Engineer. We are both located at 448-3435, ext. 255.

Sincerely,

Patrick B. Murphy
Director of Public Works

PBM:km

COMMENTS ON THE SEPTEMBER 1979 PHASE I DRAFT PLAN OF STUDY

In July 1979 the St. Paul District sent out a draft of the plan of study for the phase I general design memorandum. The following agencies sent comments on the plan of study.

U.S. Fish and Wildlife Service
U.S. Department of Transportation
Minnesota Historical Society
Minnesota Department of Health
Minnesota Department of Natural Resources
Minnesota State Planning Agency
Minnesota Pollution Control Agency
U.S. Environmental Protection Agency

Copies of the letters and Corps responses are shown here.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U.S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-PB

27 July 1979

Inclosed for your review is a copy of the draft plan of study for the Minnesota River at Chaska, Minnesota, Phase I General Design Memorandum. Funds were appropriated this fiscal year to begin the Phase I General Design Memorandum stage of planning for the project which includes flood damage reduction improvements on the Minnesota River, East Creek, and Chaska Creek. The project was authorized by the Water Resources Development Act of 1976 (Public Law 94-587).

Phase I investigations are limited to studies necessary to insure that the authorized plan or a modification reflects current public desires and meets current standards for national economic efficiency, environmental quality, regional development, and social well-being. Any departures from the authorized plan must be fully documented and justified in the Phase I General Design Memorandum. Upon approval of the Phase I General Design Memorandum by the Chief of Engineers, we will proceed with detailed designs for specific features of the project insofar as available funds permit.

If you have comments on the report, please return them to us by 31 August 1979. If you need further information, please contact us. Mr. Herb Nelson (612-725-5472), project manager, can provide additional details.

J R Calton

J. R. CALTON
Chief, Planning Branch
Engineering Division

1 Incl
As stated

Identical letter to:
(see attached list)

Identical letter to:

Mr. Erling Weiberg
Executive Secretary
Minnesota Water Resources Board
555 Wabasha - Room 206
St. Paul, Minnesota 55102

Mr. Arthur Sidner
Director, Minnesota State
Planning Agency
101 Capitol Square Building
550 Cedar Street
St. Paul, Minnesota 55101

Mr. John E. Boland
Chairman, Metropolitan Council
300 Metro Square Building
Seventh and Robert Streets
St. Paul, Minnesota 55101

Mr. Richard Hale
Director, Division of
Environmental Health
Minnesota Department of Health
717 Delaware Street SE
Minneapolis, Minnesota 55440

Mr. Charles Kenow
Environmental Quality Council
100 Capitol Square Building
550 Cedar Street
St. Paul, Minnesota 55101

Ms. Liza Nagle
Environmental Assessment Officer
Minnesota Historical Society
Building 25 - Fort Snelling
St. Paul, Minnesota 55111 (2 cys)

Mr. Richard E. Friedman
Regional Director, Region V
Public Health Service
300 South Wacker Drive
Chicago, Illinois 60606

Mr. [illegible] Mendelsohn
Regional Hydrologist, Central Region
National Weather Service
601 East 12th Street - Room 18[illegible]
Kansas City, Missouri 64106 (2 cys)
Mr. John V. Graff
Supervisory Meteorologist
National Weather Service
Federal Aviation Building
6301 34th Avenue South
Minneapolis, Minnesota 55450

Mr. Donald R. Albin
District Chief
U.S. Geological Survey
702 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Mr. Neil S. Haugerud
Chairman, Upper Mississippi River
Basin Commission
510 Federal Building
Fort Snelling
Twin Cities, Minnesota 55111

Mr. Ronald Gatton
Regional Administrator, Region V
Federal Housing Administration
300 South Wacker Drive
Chicago, Illinois 60606 (3 cys)

Ms. Christy A. H. Caine
Minnesota State Archeologist
State Archeologist's Office
Hamline University
St. Paul, Minnesota 55101

Chicago-Milwaukee Corporation
516 West Jackson Boulevard
Chicago, Illinois 60606

Mr. [illegible]
[illegible]
[illegible]
[illegible]
[illegible] Street
St. Paul, Minnesota 55101

Mr. Frank J. Jones
Regional Director
Lake Central Region
Heritage Conservation and
Recreation Service
Federal Building
Ann Arbor, Michigan 48107

Mr. [illegible]
Regional Director
U.S. Fish and Wildlife Service
Federal Building - Fort Snelling
Twin Cities, Minnesota 55111

Mr. John [illegible]
Regional Administrator
Region V
U.S. Environmental Protection Agency
230 South Dearborn Street
Chicago, Illinois 60604 (5 cys)
(Coordinator)

Mr. [illegible] C. [illegible]
Director, [illegible] Office
U.S. Environmental Protection Agency
[illegible] Avenue South
Minneapolis, Minnesota [illegible]

Mr. L. [illegible] Carlson
Division Engineer
Federal Highway Administration
Metro Square Building - Suite 490
St. Paul, Minnesota 55101 (2 cys)

Ms Terry Hoffman
Executive Director
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113

Mr. Joseph Alexander
Commissioner, Minnesota Department
of Natural Resources
Centennial Building - Third Floor
St. Paul, Minnesota [illegible]

Mr. [illegible] L. [illegible]
Chief Engineer
Metropolitan Waste Control Commission
350 Metro Square Building
Seventh and Robert Street
St. Paul, Minnesota 55101

Honorable Tracy Swanson
Mayor of Chaska
205 East Fourth Street
Chaska, Minnesota 55318

Mr. F. C. Marshall
Assistant Commissioner
Minnesota Department of Transportation
413 Transportation Building
John Ireland Boulevard
St. Paul, Minnesota 55155

Mr. Patrick Murphy
Director of Public Works
Carver County
Chaska, Minnesota 55318

Mr. Jim Olson
City Engineer for Chaska
Bonestroo, Rosene, Anderlik & Associates,
2335 West Highway 36
Roseville, Minnesota 55113

Mr. [illegible] H. [illegible]
Chaska City Administrator
205 East Fourth Street
Chaska, Minnesota 55318 (15 copies)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
TWIN CITIES AREA OFFICE
530 Federal Building and U.S. Court House
316 North Robert Street
St. Paul, Minnesota 55101

IN REPLY REFER TO

Colonel William W. Badger
Dist. Engineer, St. Paul Dist.
U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

The U.S. Fish and Wildlife Service has reviewed the draft Plan of Study dated July 1979 for the Chaska Flood Control Project in Chaska, Minnesota. We offer the following comments:

1. Page 17. The document states that the security and well-being of the residents of Chaska and flood damage reduction are the two most *important* study considerations, with fish and wildlife receiving "somewhat lower priority." While we recognize the importance of these two considerations, the Fish and Wildlife Coordination Act requires that wildlife conservation receive equal consideration with other features of water resource development projects. This paragraph should be amended in the final Plan of Study to indicate that fish and wildlife resource conservation will be given equal consideration and priority with other project features. In this regard, we suggest a *statement* be included on page 19 to indicate that a planning objective of the study is to avoid adverse impacts to fish and wildlife resources. Those which are unavoidable will be minimized and compensated for.

2. Page 18d. We agree with the statement that construction activities should be avoided in our Minnesota Valley National Wildlife Refuge. In addition to direct adverse project-related impacts to refuge lands, we are also concerned with potential adverse environmental impacts to Chaska Lake and surrounding lands. Expediting flood waters through the upper reaches of Chaska Creek could back flood waters into Chaska Lake, causing increased siltation, damage to ground nesting birds, and make management of this area for wildlife much more difficult. The Plan of Study should address these concerns.

3. Page ~~34~~ B-4. The document states the proposed bypass channel will *not* effect adjacent wetlands due to the use of an impervious barrier along the bypass channel. This statement seems premature since page 36 of the document states that bypass channels could cut off groundwater recharge of wetlands or allow for their *drainage*. Impacts on wetlands adjacent to the bypass channels will not be adequately determined until further studies are completed.

CORPS RESPONSE

1. Noted. Wording changed on page 15.
2. General project impacts on fish and wildlife resources are considered in the national objectives discussed on pages 8 and 32-35.
3. Noted. This concern has been added to the "Public Concerns" section.
4. Noted. Discussion of 1973 comment removed from page B-3. Proposed studies to determine impacts on wetlands are listed in the table on page 43.

We also question the document's statement that the proposed project would not affect upstream wetlands. Many projects involving drainage or filling of wetlands do not require individual state and/or federal approval. Drainage and conversion of upstream wetlands could be conducted without such authoriza-
5 tion and may be facilitated by the proposed project since the threat of potential floods to Chaska via Chaska and East Creeks will be eliminated or reduced by the proposed bypass channels. The statement in the document should be deleted or amended.

4. Page B-5. To date, the adequacy of the project's environmental features as suitable mitigation for project-related losses to fish and wildlife resources has not been documented. Although we fully support the concept, we do not consider the proposed green-belt and open space acquisition programs by the City of Chaska as mitigation for losses to fish and wildlife resources
6 resulting from the proposed project. The City of Chaska is using federal aid to purchase these areas independent of the flood control project. With the cooperation of your agency and the Minnesota Department of Natural Resources, we hope to develop and submit to you a mitigation plan based on our Habitat Evaluation Procedures to adequately compensate for unavoidable project-related losses to fish and wildlife resources.

5. Page B-13. To facilitate our review of the project, the final plan
7 should address those items discussed in our letter on this page. Although mention is made of the green-belt and open space acquisition programs, no specific information is provided as requested in our attached letter of October 31, 1973. The final document should also discuss the project's conformance
8 with Executive Orders 11988 (Floodplain Management) and 11990 (Wetland Protection), which is omitted in the draft.

6. Page 21. During a field review of the project area, the trailer court indicated on the attached map has been substantially expanded to the east since the final Environmental Impact Statement (EIS) was circulated. The proposed
9 East Creek bypass channel will bisect this area including the trailer court. This should be evaluated in your technical studies along with any further land use changes since the final EIS.

With the above considerations included, we feel your draft Plan of Study will adequately determine project-related impacts to fish and wildlife resources. We will be looking forward to working with your agency to assure that adverse project-related losses to fish and wildlife resources are minimized and appropriately compensated for.

We appreciate the opportunity to offer our comments concerning this matter.

Comments regarding endangered or threatened species will be forwarded under separate cover.

Sincerely yours,

John W. Duan
Acting Area Mgr.

CORPS RESPONSE (CONT.)

5. Statement on 1973 comment deleted. However, major drainage channels and extensive upstream channel improvements would be required before the upstream wetlands could be drained. The authorized bypass and diversion channels would not be located to directly cause upstream wetland drainage. Draining and filling of upstream wetlands are not considered to be a direct impact caused solely by the authorized project and, therefore, will not be considered in impact evaluation studies.

6. Statement on 1973 comment deleted. Fish and wildlife impacts and the possible need for mitigation are discussed on pages 41-43, 52, and 53.

7. This information will be formally coordinated during the triagency analysis described on pages 41-43, 52, and 53.

8. Noted: see page 38, "Economics."

9. Noted: the entire authorized plan will be reevaluated to determine its impacts on land uses which have changed since the feasibility report.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION 5
Suite 490, Metro Square Building
St. Paul, Minnesota 55101

August 3, 1979

IN REPLY REFER TO

Colonel William W. Badger
District Engineer
Department of the Army
St. Paul, District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

Thank you for the opportunity to review the draft plan of study for the Minnesota River at Chaska, Minnesota, Phase I General Design Memorandum, which was transmitted with your July 27, 1979 letter. We have no further comments to offer beyond those expressed in our January 24, 1979 letter.

1 As noted in our previous letter, we would appreciate continued receipt of documents appraising FHWA of progress on the Chaska project as it may effect future Federal-aid highway projects.

Sincerely yours,

E. Dean Carlson
Division Administrator

CORPS RESPONSE

1. Noted.

MINNESOTA HISTORICAL SOCIETY
690 Cedar Street St. Paul Minnesota 55101 • 612 296 2747

CORPS RESPONSE

1. Noted.

August 14, 1979

Colonel William W. Badger
District Engineer
St. Paul District
Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

RE: Review of Draft Phase I General Design
Memorandum Plan Formulation Flood Damage
Reduction at Chaska, Minnesota, Carver County

MHS Referral File Number H280

Thank you for the copy of the above referenced report. It is stated on page 34 of the report that a literature search along with a surface reconnaissance (accompanied by subsurface testing) will be conducted in project-affected areas. We heartily concur with your intentions to identify cultural resources in the project area.

If we can be of any assistance, please do not hesitate to contact Ms. Susan Queripel, Environmental Assessment Officer, State Historic Preservation Office, Minnesota Historical Society, James J. Hill House, 240 Summit Avenue, St. Paul, Minnesota 55102, phone (612) 296-0103.

Thank you for your participation in this important effort to preserve Minnesota's heritage.

Sincerely,

Russell W. Fridley
State Historic Preservation Officer

RWF/cjb

minnesota department of health
717 s.e. delaware st minneapolis 55440

September 24, 1979

Mr. J. R. Calton, Chief
Planning Branch
Engineering Division
Department of the Army
St. Paul District Corps of Engineers
1135 U.S. Post Office and Customs House
St. Paul, Minnesota 55101

Dear Mr. Calton:

Subject: Minnesota River at Chaska - Phase I - General Design Memorandum

1 We have reviewed the draft plan of study for the Minnesota River at Chaska, Minnesota, Phase I - General Design Memorandum. Our major concern is the need for a serious hydrologic study addressing the effects of this project on groundwater quality and supply, particularly with the transfer of East Creek water across watersheds. Our initial impressions are that this project may actually safeguard groundwater and potable water supplies by preventing flood-transported contaminants from entering improperly constructed or abandoned wells or from damaging water distribution and treatment systems.

2 The environmental concerns and considerations outlined on pages 22-23 are very general, and any further studies will require the determination of the specific environmental consequences if this project is implemented.

If we may be of any assistance to you, please do not hesitate to contact our staff.

Sincerely,

Roger L. DeRoos, Ph.D., Director
Division of Environmental Health

an equal opportunity employer

CORPS RESPONSE

1. The table on page 43 lists the possible impacts of the East Creek bypass. The studies to determine the impacts are also listed.

2. Environmental considerations listed on pages 26-27 are general for the purposes of formulating and evaluating all possible alternatives to the authorized project. Some of the specific studies to determine the environmental impacts of the authorized plan are listed on pages 13, 39-44, 52, and 53.

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
444 Lafayette Road, 3rd Floor Space Center Bldg., St. Paul, MN 55101

PHONE

September 20, 1979

Mr. J. R. Calton
Chief, Planning Branch
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, MN 55101

Dear Mr. Calton

DRAFT PLAN OF STUDY - MINNESOTA RIVER AT CHASKA, MINNESOTA

We have reviewed this document as requested in your letter of July 27, 1979 and offer the following comments:

1. Page 3, Last Paragraph. We realize that there is an internal study procedure (including submittal, review, and comment time periods) that your agency must follow. This is fairly clear as it is presented in terms of the study phases discussed in this paragraph. However, the clarity is soon lost in the remainder of the report when references are made to the various stages, i.e. stages 1, 2, 3, and ultimately "tentative stage 3 methodology". The text and tables reference stage 3 on page 23, stage 2 on page 24, stage 1 on page 25, and various other stage references on pages 38, 39, 40, and 41. Please note that these references do not follow chronological order nor are they explained or defined as to their significance in the study process. They are totally confusing to anyone not versed in Corps "jargon". If your regulations require such numerical references in these plans of study, we would recommend that you include an explanation of the meaning and timing of these "stages". If the references are not necessary, it would be better to delete them in the interest of clarity.

2. Page 4, "Studies by Others". We feel this list should be expanded to include the following documents:

   "Flood-Plain Areas of the Lower Minnesota River", United States Department of the Interior, 1973.

   "Flood Insurance Study, City of Chaska, MN, Department of Housing and Urban Development, April 1977."

3. Page 11, First Paragraph, Second Sentence. This statement causes us much consternation both in terms of its content and intent. On page 10, the Blue Earth Reservoir is discussed quite well as it is stated that it will provide "a high degree of protection at Chaska". However, as stated on page 11, ". . . a major reservoir system . . . could provide permanent protection from Minnesota River flooding. . .". Unless

CORPS RESPONSE

1. An explanation of the meaning and timing of the stages of the phase I study has been added to "The Report and Study Process" section on page 6.

2. Noted: Items added to list.

a state had been made to underlying such a conclusion, we must question this statement's validity. The last part of the same statement goes on to state, ". . . until support of the reservoir system by the State [illegible]", and contains the same circular logic, in that it would be extremely difficult for the state to support such a system until a state "justified" the need for such a system. Therefore, we must question the entire statement and certainly cannot support its conclusion as it is currently written unless your agency can document otherwise.

4. Page 11, Paragraph 1, and Page 24, Last Paragraph. Both paragraphs indicate that a potentially hazardous condition exists at the Minnesota Highway 41 crossing [illegible] creek. This agency will investigate this situation and if a potentially hazardous condition exists, we will propose corrective action. However, we would point out that your agency may possess similar authority through the Federal Dam Inspection and/or Dam Safety Program. Also, as per our previous comments concerning the development and implementation of a flood warning system, we would expect a thorough discussion of this potentially hazardous condition in the *immediate future.*

5. Page 14, Last Paragraph, Last Sentence, and First Sentence on Page 15. These statements do not reflect the current requirements of the City of Chaska's flood plain zoning regulations. New flood plain development is required to be elevated or flood proofed above the 100-year flood level. The flood protection requirements are acknowledged on page A-5 and we recommend that the identified sentences reflect this.

6. Page 38, Last Paragraph. AppendixC is referenced but is not included in t document.

7. Pages B-3, Last Paragraph, and B-8, Last Paragraph. The statements attributed to the Division of Game and Fish are taken from our letter of June 21, 1973 and it appears that you have rather broadly interpretted them. As we further stated in my letter of December 29, 1978, we are concerned about the project's impacts on river bottom wetlands and a detailed analysis would be necessary to determine specific impacts. Furthermore, the DNR permit process will require proper mitigation for any negative impacts to wildlife and fishery resources (specifically Court House Lake) and will be based upon the detailed impact analysis.

We trust these comments are useful. If you have any questions or care to discuss them further, please contact Ed Fick of our Division of Waters (296-0439).

Yours truly,

Joseph N. Alexander
Commissioner

cc: Larry [illegible], Director of Waters
[illegible], Regional Hydrologist, Metro
Earl Haber, Ecological Services

CORPS RESPONSE (CONT.)

3. Noted: statement removed.

4. Noted: we intend to investigate this situation further.

5. The statement on page 14 was meant to describe the effects of possible future floodplain development on the aesthetic aspects of the riverine environment.

6. Appendix C is budgetary information for Corps of Engineers review only.

7. Our discussion of your comments on page B-3 has been removed from the report. Studies to determine impacts on fish and wildlife and the possible need for mitigation are discussed on pages 41-43, 52, and 53.

Minnesota State Planning Agency
101 Capitol Square Building
550 Cedar Street
St. Paul, Minnesota 55101
Phone 296-[illegible]

August 28, 1979

Colonel William W. Badger
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

RE: NCSED-PB - Phase 1 General Design Memorandum Flood Damage Reduction - Chaska,

Dear Colonel Badger:

1 A management plan for stormwater runoff within the Chaska Creek Watershed should be included as an essential part of the flood damage reduction plan. The adoption of a watershed management plan by the local units of government should preclude any structural control activity. A fully
2 integrated management approach utilizing both land use and structural controls would assure the residents' safety and provide for a practical and cost-effective method of flood control.

Thank you for the opportunity to comment on the memorandum. If there are any questions please call Rand Kluegel at 296-3584.

Sincerely,

Charles R. Kenow

Charles R. Kenow, Acting Manager
Program Analysis & Project Evaluation

CRK RK/bb

cc: Tom Balcom, DNR

1. The extent of our studies [illegible] It will be to design the interior drainage system for the area [illegible] the Minnesota River levee. The city [illegible] is presently studying an enlargement of the existing stormwater removal system. We will coordinate the stormwater study information with the city [illegible].

2. Even with proper watershed management, Chaska and East Creeks would need to be modified to provide adequate interior drainage for the Minnesota River levee. We will, however, encourage proper development and watershed management in the area.

Minnesota Pollution Control Agency

AUG 2 5 1979

Colonel William W. Badger
U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Attention: NCSED-PB

Dear Colonel Badger:

This is in response to your draft "Phase I General Design Memorandum, Plan Formulation, for flood damage reduction at Chaska, Minnesota", dated July, 1979.

It is our understanding that the primary purpose of the Phase I General Design Memorandum is to list the problem areas related to the authorized plan and to propose areas where you may need to reevaluate the plan and formulate possible alternatives. We therefore feel it is appropriate to reiterate our concerns for certain aspects of the project and to request continued communication regarding their resolution.

1) The water quality impacts you have noted in your problems, needs, and opportunities section, page 15 of the draft memorandum, continue to be of concern to the Minnesota Pollution Control Agency (MPCA). You have noted that the Minnesota River may be affected by oxygen depletion during low flows. An indepth evaluation of this problem should be conducted using any current information which may be available. It should be noted that the Chaska wastewater treatment plant is currently being updated in order to comply with applicable water quality standards.

2) The effects of population and urbanization and your construction activities on water, wetland, and flood plains should be considered. We are especially concerned that the East Creek bypass channel may impact significant wetland areas where drainage, development, and siltation should not be allowed. The potential impacts of the bypass should be fully considered and mitigation of any impacts should be considered.

3) In response to our previous comments regarding the nature of the excavated materials, you have noted that soil borings would be taken and that material unsuitable for use in the dikes would be placed in an as yet undetermined site. We continue to be concerned about the placement of the excavated material. If there is a potential that the soils could be contaminated, chemical analysis of the materials should be conducted.

CORPS RESPONSE

1. Noted that proposed water quality monitoring program and studies are discussed on pages 42 and 43.

2. These impact studies are addressed on pages 42 and 43.

3. Studies to determine project impacts on fish and wildlife habitat and consider possible mitigation can be found on pages 41-43, 52, and 53.

4. If during our investigation we find evidence that the soil could be contaminated, chemical analysis of the materials will be conducted and adequate placement controls will be developed in cooperation with the Minnesota Pollution Control Agency.

Colonel William W. Badger
Page Number Two

Thank you for this opportunity to comment. If you have any questions, please feel free to contact me or Mr. Louis Flynn of my staff at (612) 296-7225.

Yours truly,

Barry C. Schade
Acting Director
Division of Water Quality

BCS/LLF js

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
[illegible]

23 AUG 1979

[illegible]
[illegible] Branch
[illegible] Division
[illegible] Army Engineer District, St. Paul
[illegible] U.S. Post Office and Custom House
St. Paul, Minnesota [illegible]

Dear Mr. [illegible]alton:

[illegible] you for [illegible] July 27, 1979, letter regarding the draft plan of [illegible] for the Minnesota River at Chaska, Minnesota, Phase I General [illegible] Documentation.

[illegible] current workload, we will be unable to review the subject [illegible] up to date as the project progresses. If [illegible] regarding this matter, please contact me, at [illegible]

AD-A184 474 MINNESOTA RIVER AT CHASKA MINNESOTA TECHNICAL APENDIXES LIMITED REEVALUA..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT AUG 82

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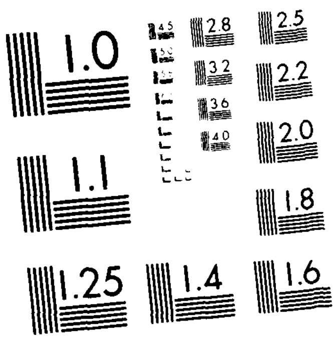

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NATIONAL BUREAU OF STANDARDS-1963-A

CHASKA FLOOD CONTROL STUDY

Minnesota River
East And West Creeks

ST. PAUL DISTRICT CORPS OF ENGINEERS

progress report

SEPTEMBER 1979

This is the first in a series of progress reports concerning the Chaska flood control study. This report is designed to inform you of study activities and provide you with the background information needed for effective participation in the Chaska flood control study. Results of study activities will be presented in these reports as will any decisions based on those results. This study, conducted by the U.S. Army Corps of Engineers in cooperation with the city of Chaska and other government agencies, takes a comprehensive approach to water and related land resource management. Concerns of flood control, water quality, and recreation are being investigated.

WHY DO WE NEED ANOTHER STUDY ?

In 1973, a flood control plan for Chaska was recommended to Congress by the Corps of Engineers as a result of the feasibility study done by the Corps St. Paul District. Congress reviewed the recommendation and in 1976 authorized the recommended plan for construction. Last fall Congress first appropriated funds for the Chaska project. The first step in the construction effort is to review the past study; apply current criteria; and develop more detailed engineering, economic, and environmental information.

The main reason for the present study is to determine if any changes which affect the authorized plan occurred during the congressional review. Also, the study will address questions concerning the plan raised by the various review agencies. A nonstructural flood damage reduction plan will be developed for comparison with the authorized structural plan.

The present study is expected to be completed in June 1981. If this phase of the study goes smoothly, plans and specifications for construction could be nearly complete in 1983. These studies must be complete before Congress could appropriate money for actual construction work.

STUDY PROGRESS

The first stage of this three-stage study is a plan of study which was submitted to the Corps Chicago office in July 1979. The plan of study is being reviewed by the Chicago office and other government agencies, including the city of Chaska. Review of the plan of study should be completed by September 1979. Work is already in progress to develop background information for the second stage which will consist of reevaluating the authorized plan and developing a nonstructural plan for comparison.

It is expected that the authorized plan will be recommended for the remaining study phases required by Congress. However, the possibility remains that the recommendation may be for a different type of flood control plan or for no Federal participation at all. Ultimately, the recommendation will be based on the findings of ongoing Corps studies.

SLIDE PRESENTATION AVAILABLE

A 20- to 25-minute slide presentation describing the authorized project and the current study effort will be available soon to clubs and civic groups. A representative of the Corps will be available to narrate the presentation and answer questions. Arrangements for use of the slide presentation can be made through the Chaska City Administrator's office (phone 448-2851) or directly through the Corps project manager, Mr. Herb Nelson (phone 612-725-7472). The slide presentation is tentatively scheduled for a public showing at the regular Chaska Planning Commission meeting on 18 October 1979.

FUTURE PROGRESS REPORTS

Other progress reports will be mailed to you as the study continues. These reports will keep you aware of study accomplishments and of your opportunity to participate in public meetings, workshops, and similar activities.

If you do not wish to remain on our mailing list, or if you know of someone who should receive the progress reports, please call the city administrator's office (phone 448-2851) or contact:

District Engineer
St. Paul District
U.S. Army Corps of Engineers
ATTN: Advance Planning Section
Planning Branch
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Your ideas and feelings about the project are important. Proper decisions concerning flood control for Chaska can be made only if affected citizens become involved in the study. Public participation is invited in workshops, meetings, and similar activities to be scheduled and coordinated with the city administrator's office. All activities will be announced in advance.

CHASKA, MINNESOTA
FLOOD CONTROL PROJECT

With passage of the Water Resources Development Act of 1976 (Public Law 94-587), Congress authorized the Chaska flood control project. As approved, the project includes a variety of measures to reduce flood damages on the Minnesota River, East Creek, and West (Chaska) Creek. The project also includes a number of recreational features to enhance the recreation opportunities in the area. The attached map shows the locations of the authorized flood control works.

LEVEE

The existing levee built by the city will be improved and extended to protect Chaska from Minnesota River flooding. The principal features of the work are:

- About 6,000 feet of upgraded levee (city levee).
- About 3,200 feet of new levee.
- Four pumping stations with ponding areas.
- About 5,000 feet of stormwater interceptor sewers.
- A relief well system.

EAST CREEK BYPASS

The proposed bypass channel would divert excess flood flows around the east side of the city directly to the Minnesota River. Under normal flow conditions, water will continue to flow through the natural creek channel.

WEST CREEK DIVERSION

The proposed West Creek diversion channel would safely carry West Creek floodwaters through the industrial zone on the west side of Chaska to the Minnesota River floodplain. The existing channel in this reach would carry local runoff only.

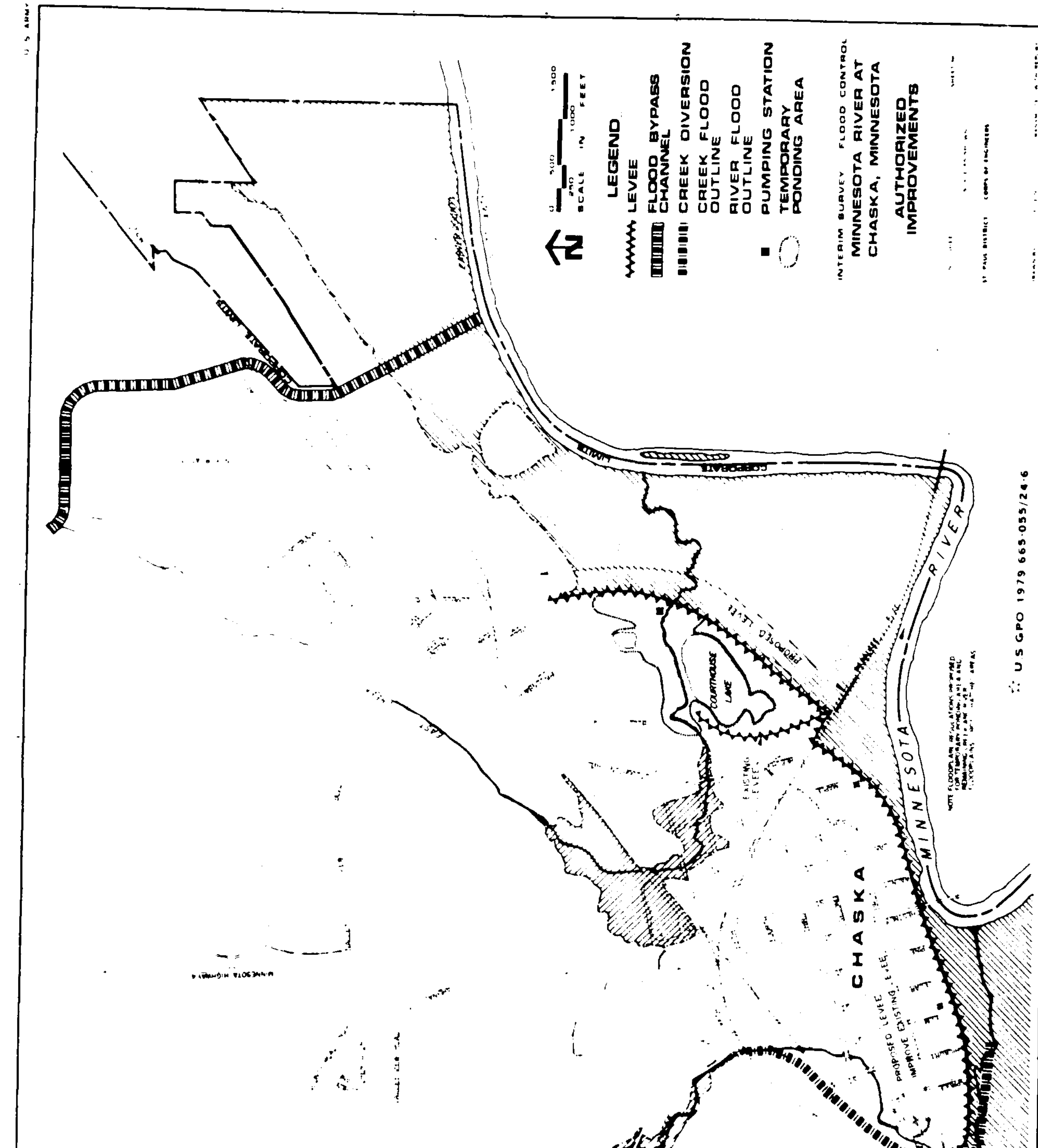
FLOODPLAIN REGULATION

Ponding areas and remaining unprotected portions of the river and creek floodplains would be subject to floodplain regulation to prevent damage to future development.

RECREATION

The authorized project calls for about 1½ miles of paved recreation trails on top of the levee and around Courthouse Lake. These trails would complement the open-space stream corridor system being considered by Chaska and could be connected to the Minnesota River valley trail system being developed by the State.

Courthouse Lake will be protected from Minnesota River flooding to preserve the trout fishery being maintained by the Minnesota Department of Natural Resources.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MINNESOTA RIVER AT CHASKA, MINNESOTA
AUTHORIZED IMPROVEMENTS
CHASKA
MINNESOTA RIVER
COURTHOUSE LAKE
PROPOSED LEVEE
EXISTING LEVEE
CORPORATE LIMITS
MINNESOTA HIGHWAY
U S GPO 1979 665-055/24-6

CHASKA FLOOD CONTROL STUDY

Minnesota River
East And West Creeks

ENGINEERING ENVIRONMENT ECONOMICS

ST. PAUL DISTRICT CORPS OF ENGINEERS

progress report

DECEMBER 1979

This is the second in a series of progress reports concerning the Chaska flood control study. This report is designed to inform you of study activities and provide you with the background information needed for participation in the Chaska flood control study.

DID YOU MISS THE FLOOD CONTROL SLIDE PRESENTATION ?

The Corps of Engineers has already shown the Chaska flood control slides at a Planning Commission meeting and at the fire hall to a group of firefighters.

The presentations lasted 45 minutes to 1 hour each, including discussion time. The meetings were brief, but some important information was exchanged.

Typical questions included:

1. When could the Corps of Engineers start building the flood control project at Chaska?

Answer: The project could be entirely constructed by 1988 if all phases of the study and the design and construction process proceed as planned.

2. Improving the levee includes making it wider at the bottom and higher. Would this require more land on the home side of the levee? Would any homes need to be removed?

Answer: Wherever possible, the levee will be enlarged on the river side to avoid houses and other improvements. However, the portion of the levee near the Highway 41 bridge is too close to the river for improvement on the river side. Some homes would probably have to be removed there. The design of the levee improvement should be completed by March 1980. This design will tell us which buildings would have to be removed.

3. Where would the proposed East Creek bypass go? Would any homes or businesses need to be removed? Could the location be changed?

Answer: The proposed creek bypass is shown on the attached map. The design of the proposed bypass channel should be completed by March 1980. Homes might have to be removed in two general areas where East Creek leaves the bluff line near County Road 17 and between Stoughton Avenue (near the Gedney Plant) and the Minnesota River. Alternative locations for the bypass channel could be considered in the spring. This would be after the completion of the reevaluation of the authorized location of this channel.

4. How much would the city have to pay for the project?

Answer: The present estimate is:

Land and damages	$860,000
Home, bridge and utility relocations	1,630,000
Recreation Facilities	30,000
Total	$2,520,000

Note: The city already owns some of the land required for the proposed project.

We will be presenting the slide show again for those of you who couldn't attend before. If you have any questions concerning flood control, you should attend the presentation and discussion.

PLACE:	Community Room of the First National Bank 301 Chestnut in Chaska
DAY:	Tuesday, December 11, 1979
TIME:	7:30 P.M.
WHAT:	Slide presentation and discussion
WHO:	Anyone interested in flood control for Chaska should attend the meeting.

Stage 2 Planning

STUDY PROGRESS

The main thrust of the work being accomplished is to determine whether the proposed plan, as presented in the 1973 feasibility report, meets current conditions and criteria.

Some of the work items include:

1. Economic studies are being accomplished to determine the project benefits under today's conditions. New development, rising real estate values, and inflation may have increased the project benefits.

2. The designs of the creek bypass and diversion channels are being reviewed. Estimates of flood flows and frequencies on the two creeks have been modified because of the recent results of a study method not available for the 1973 report. The changes in creek flows will require some changes in the diversion and bypass channel sizes. Some railroad and highway bridges over the creeks or needed for the channel improvements have been abandoned or rebuilt since the 1973 report. Those bridges may not need to be built or replaced.

3. Last June, soil borings were taken and, in August, the soil samples were tested. This information is being used to review the design of the levee improvement and seepage control measures. These designs should better define the amount of land required for the levee and the seepage measures.

4. The interior drainage system for the levee area is being redesigned. The orignal design includes four new pumping stations, a stormwater interceptor sewer, and temporary ponding areas as shown on the inclosed map. New design methods have been developed for interior drainage systems since the interior drainage was designed for Chaska in 1973. The new design method is not expected to significantly change the type of interior drainage system, but could affect the size of the pumping stations and ponding areas. Real estate requirements will also be determined.

5. Project costs will be estimated using the new levee, bypass, diversion, and interior drainage designs. Current real estate costs will also be determined.

LOOKING AHEAD

Our reanalysis of the proposed plan assumes that the levee and creek channel improvements are located, as shown on the attached map. If the proposed project still seems reasonable after the reanalysis, we may spend a few months analyzing alternative locations for the levee, diversion channel, and bypass channel.

We will review alternatives to reduce cost, avoid taking homes or businesses, and lessen any adverse impacts. This information would then be available for two public workshops scheduled for February or March 1980.

The purpose of the workshops would be to obtain public input concerning the location and impacts of these project features. More information concerning these workshops will be available in a future notice.

BENEFITS AND COSTS OF THE PROPOSED PROJECT

Our best present estimate shows that the proposed project provides only $1.06 in project benefits for every $1.00 in project costs on an average yearly basis. National policy requires that all flood control projects provide more average annual benefits than costs. Congress uses this information to set nationwide priorities for appropriation of construction funds to hundreds of projects across the Nation.

Project costs are a combination of construction and maintenance costs. Project benefits are mostly dollars of reduced flood damage. By February or March 1980, we should have a reasonable idea of how the project benefits and costs have changed since the last time they were extensively studied in 1973.

Basically, one of two situations could develop when we know bette what the project benefits and costs are:

FIRST SITUATION Benefits remain higher than costs. We would continue the study as planned with the proposed plan likely to be recommended for final designs, plans and specifications, and construction.

OR

SECOND SITUATION Benefits have become less than costs. We would no longer be able to recommend the proposed plan for construction. If we could develop an alternative flood control plan that could satisfy all the requirements, we could consider that plan. If no alternative plans are determined to meet the requirements we would recommend no further study at this time. However, emergency help and technical assistance would still be available to the city.

FUTURE PROGRESS REPORTS

Other progress reports will be mailed to you as the study continues. These reports will keep you aware of study accomplishments and of your opportunity to participate in public meetings, workshops, and similar activities.

If you do not wish to remain on our mailing list, or if you know of someone who should receive the progress reports, please call the city administrator's office (phone 448-2851) or Mr. Herb Nelson (phone 612-725-7472) or contact:

District Engineer
St. Paul District
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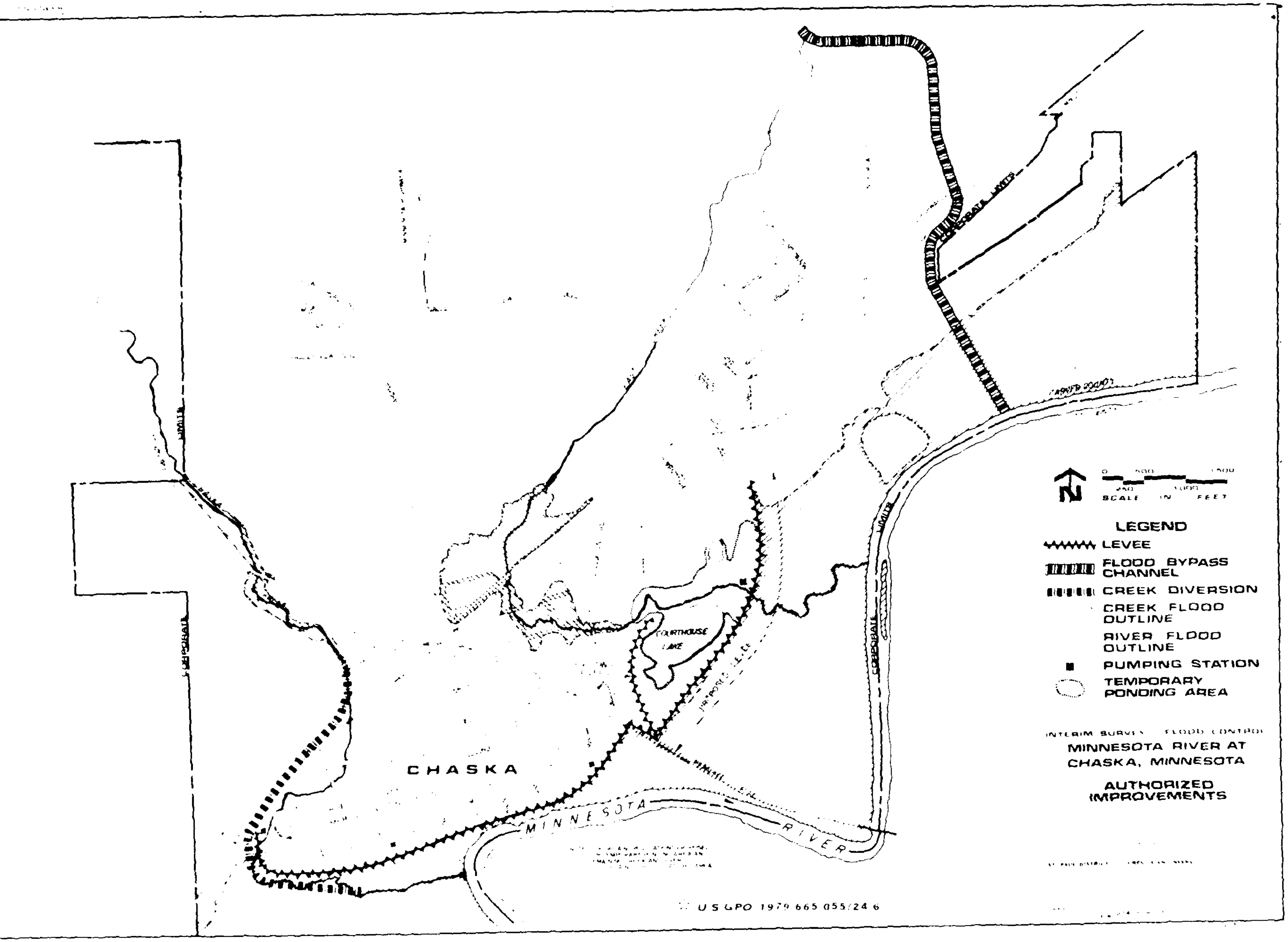
ATTN: Advance Planning Section
Planning Branch
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Your ideas and feelings about the project are important. Proper decisions concerning flood control for Chaska can be made only if affected citizens become involved in the study. Public participation is invited in workshops, meetings, and similar activities to be scheduled and coordinated with the city administrator's office. All activities will be announced in advance.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CREEK FLOOD OUTLINE
RIVER FLOOD OUTLINE
PUMPING STATION
TEMPORARY PONDING AREA
SCALE IN FEET
INTERIM SURVEY FLOOD CONTROL
MINNESOTA RIVER AT
CHASKA, MINNESOTA
AUTHORIZED
IMPROVEMENTS
CHASKA
MINNESOTA RIVER
COURTHOUSE LAKE
CORPORATE LIMITS
U S GPO 1979 665 055/24 6

CARVER COUNTY HERALD 11
Wednesday, Nov. 28, 1979

Second flood control project report released by Corps of Engineers

By Al Lohman

The St. Paul District Corps of Engineers has issued the second in a series of progress reports concerning the Chaska flood control study.

The Corps of Engineers has already outlined the flood control plan through a slide show at a Chaska Planning Commission meeting and to a group of firefighters. The plan calls for an addition to the present dike both in height and length, broadening the base of the dike and adding seepage resistant material, adding sewer interceptor sewer and pump stations. In addition a bypass would be constructed on the East Creek and the West Creek's flow would be diverted.

In its latest report the Corps answered some questions that were asked at the presentations.

When could the Corps start building the flood control project?'

The project could be entirely constructed by 1988 if all phases of the study and the design and construction process proceed as planned," states the report.

Would making the levee wider at the bottom require more land on the home side of the levee and would any homes need to be removed?:

The Corps answer goes, "Whenever possible, the levee will be enlarged on the river side to avoid houses and other improvements. However, the portion of the levee near the Hwy. 41 bridge is too close to the river for improvement on the river side. Some homes would probably have to be removed there. The design of the levee improvement should be completed by March 1980. This design will tell us which buildings would have to be removed."

How much would the city have to pay in the $15 million project?:

The present estimate is $2.5 million of which $1.6 million would go for home, bridge and utility relocations," the Corps responded.

The progress report also outlined what is being done on the flood control study.

The main thrust of the new study is to determine whether the proposed plan, as presented in the 1973 feasibility report, meets current conditions and criteria.

Economic studies are being done to determine the project benefits under today's conditions. New Developments, rising real estate values and inflation may have increased the project benefits. Cost-benefit ratio is an important factor in congressional determination for funding such a project. The Corps present estimate shows that the proposed project provides only $1.06 in benefits for every dollar in costs, a very low ratio.

The designs of the creek bypass and diversion channels are being reviewed. Estimates of flood flows and frequencies on the two creeks have been modified. The changes in creek flows will require some changes in the diversion and bypass channel sizes.

The progress report notes that soil borings were taken last June and in August the soil samples were tested. The information is being used to review the design of the levee improvement and seepage control measures. According to the Corps, these designs should better define the amount of land required for the levee and seepage measures.

The interior drainage system for the levee area is being redesigned to include four new pumping stations, a stormwater interceptor sewer and temporary ponding areas.

Project costs will be estimated using the new levee, bypass, diversion and interior drainage designs. Current real estate costs will also be determined.

"If the proposed project still seems reasonable after the reanalysis, we may spend a few months analyzing alternative locations for the levee, diversion channel and bypass channel," the Corps said.

The Corps will review alternatives to reduce cost, avoid taking homes or businesses and lessen any adverse impacts. The information would then be available for two public workshops to be scheduled for early 1980 which would allow for public input concerning the location and impacts of project features.

If the Corps finds that benefits from the project have become less than costs, it would not recommend the proposed plan for construction, but would try to develop an alternate flood control plan to meet requirements.

"If no alternative plans are determined, we would then recommend no further study at this time," the report states. "However, emergency help and technical assistance would still be available to the city."

The Corps will be presenting another slide show and discussion of the proposed flood control project on Tuesday, Dec. 11. That public meeting will be held at 7:30 p.m. in the community room of the First National Bank.

NCSED-PB

Minnesota River at Chaska, Minnesota - Phase I GDM Studies

Memo for Record

Planning Branch
Engineering Division

13 March 1980

1. On 11 March 1980, the following people met in the Chaska City Hall:

Shirley Brewer	Acting Chaska City Administrator
Luke Melchert	Chaska City Attorney
Don Fahey	Superintendent, Chaska Public Works
Gary Staber	Chaska Building Inspector
Jim Olson	Chaska engineering consultant
Kermit Crouch	Chaska planning consultant
Rodney Gordon	Representative of Chanhassen
Dave Haumersen	Corps of Engineers
Herb Nelson	Corps of Engineers - project manager

2. The meeting was held to discuss an alternative East Creek bypass plan developed by the city engineer. A copy of a report including backup information for the plan was received at the District office on 11 March 1980. The report is a stormwater management plan submitted to the city council on 17 December 1979.

3. The city planning consultant determined that the bypass alignment in the feasibility report would significantly interfere with development plans for the area east of County Road 17 and north of U.S. Highway 212. The planning consultant believes that the alternative alignment would interfere considerably less.

4. City officials prefer the alternate alignment, but want both alignments analyzed further before a plan is selected. We told the city that a plan needs to be selected before the end of September 1980 for the Phase I GDM study. The planning consultant will send further information to help us analyze the economic benefits of the alternative alignment. He stated that the city's probable second choice would be the feasibility alignment with modifications to cause the least interference with the planned development.

5. The 27 March 1980 Corps workshop was discussed. City officials want the workshop to be held even if we have not completed the analysis of the alternative alignment. Other useful information is expected to be exchanged.

6. Chaska officials have initiated coordination with Chanhassen concerning possible real estate acquisition and rights-of-way for the alternate bypass alignment which runs through western Chanhassen. They restated their acceptance of the Chaska Creek diversion and Minnesota River levee described in the 1973 feasibility report.

HERBERT A. NELSON
Civil Engineer
Planning Branch
Engineering Division

CHASKA FLOOD CONTROL STUDY

Minnesota River
East And West Creeks

ENGINEERING ENVIRONMENT ECONOMICS

ST. PAUL DISTRICT CORPS OF ENGINEERS

progress report

MARCH 1980

This is the third in a series of progress reports concerning the Chaska flood control study.

PLANNING WORKSHOP

PLACE: COMMUNITY ROOM OF THE FIRST NATIONAL BANK
301 CHESTNUT IN CHASKA

DAY: THURSDAY, MARCH 27, 1980

TIME: 7:30 P.M.

WHO: ANYONE INTERESTED IN THE CHASKA FLOOD CONTROL STUDY SHOULD ATTEND THIS WORKSHOP

A planning workshop will be held this month as discussed in previous progress reports and at recent flood control meetings. Based on our experience at previous meetings, more time will be allowed for open discussion. We hope to promote open discussion concerning special topics by using the workshop format. Formalities of the meeting will be kept to a minimum.

The workshop will be organized so that everyone will have time to participate in two out of three available work groups. Persons attending the Design Features Work Group will be asked to comment concerning physical dimensions and locations of the features contained in the various alternatives. Participants in the Alternative Plans Work Group will discuss and comment on the various alternatives. This group will also discuss the cost, time, and the constraints used to narrow the field of alternatives. The third work group will be seeking views and comments concerning environmental issues. These concerns could include social and recreational issues in addition to fish, wildlife, wetlands, forests, and recreational areas.

Now is the time to review the available information and tell the Corps of Engineers and city officials what you think concerning the various available flood control plans and options. City and Corps of Engineers technical people will attend the workshops and will actively participate in the discussions.

Information the Corps has developed concerning the various flood control plans and options will be organized into a folder. Copies of the folder will be available at the Chaska City Hall approximately 1 week before the workshop and at the meeting on March 27.

The information gathered in the work groups will be used by the Corps to direct the flood control planning and produce the report due next fall. Our goal is to recommend a constructible flood control plan that the citizens of Chaska can accept and support.

Hopefully, this workshop will cover all the major concerns involved with Chaska flood control. If we can identify and address those problems now, we will probably not need to rework part of the study late in the study when everything should be determined and relatively firm.

FUTURE PROGRESS REPORTS

If you do not wish to remain on our mailing list, or if you know someone who should receive the progress reports, please call Mr. Herb Nelson (phone 612-725-7472).

CHASKA FLOOD CONTROL WORKSHOP

MARCH 27, 1980

7:30 P.M.

AGENDA

Introductions

Presentation of meeting format and objectives (15 minutes)

Workshop folders

Description of work group function

Use of meeting outputs in the study

Work session 1 (30 minutes)

Break into the following groups

a. Design Features - John Blackstone

b. Alternative Plans - Herb Nelson

c. Environmental Concerns - Jeannie Wagner

Standup break (5 minutes) - An opportunity to change groups

Work session 2 (30 minutes) - Similar groups as work session 1

Wrap-up

Group leader presentations (5 minutes each)

Concluding remarks - study manager

ALTERNATIVE PLANS WORK GROUP

People attending this group will be asked to comment on the various altern-ative plans available. The comments will be consolidated and used by the Corps to select the plan to be recommended in the report. We are looking for general comments on floodplain evacuation, flood forecast-warning, flood proofing, flood insurance, floodplain regulation, and the various structural plans the Corps and the City have been studying. We ask that you save any comments concerning locations, features, and other physical design recommend-ations concerning the authorized plan for the Design Features Work Group.

This work group will also briefly discuss the time, money, legal, and policy constraints that are used to narrow the field of alternatives. You will be asked to comment concerning the plan you feel the Corps should recommend.

DESIGN FEATURES WORK GROUP

People attending this work group will be asked to comment on the physical design of the authorized plan. The congressional authorization has built-in allowances for variations from the plan as described in the 1973 Corps feasibility report. The types of variations allowed will be discussed and comments will be solicited concerning channel alignments, channel sizes and levee dimensions. Alternative methods of controlling flooding from the creeks, such as building reservoirs or enlarging the creek channels, could also be discussed.

ENVIRONMENTAL CONCERNS WORK GROUP

In this group, the Corps of Engineers will be seeking your views and comments concerning environmental considerations related to the proposed plan or altern-atives. These concerns include social and recreational topics as well as natural resources topics such as fish, wildlife, wetlands, and forests. This information will be used to complete the supplement to the environmental impact statement.

DESCRIPTIONS OF THE THREE WORK GROUPS TO BE USED AT FLOOD CONTROL WORKSHOP

CHASKA FLOOD CONTROL
PLANNING WORKSHOP
MARCH 1980

CHASKA FLOOD CONTROL STUDY

Minnesota River
East And West Creeks

ST. PAUL DISTRICT CORPS OF ENGINEERS

progress report

APRIL 1980

WORKSHOP RESULTS

The March 27, 1980, public workshop was attended by approximately 60 people. The group consisted of some Chaska officials and residents, members of the Chaska Minnesota River Flood Control Association, six Corps of Engineers personnel, and one representative each from the Minnesota Department of Transportation and the U.S. Fish and Wildlife Service. The work groups collected significant information on the East Creek area, the levee area, recreation planning, and environmental concerns.

EAST CREEK AREA

In general, the Chaska residents and officials at the workshop expressed continued support for the proposed levee raise and Chaska Creek diversion. Many people participated in the discussion of East Creek flood protection. Support was expressed for a bypass channel alignment going into Chaska's corporate boundaries, [illegible] the existing and planned [illegible]. Several other possible alternative plans were also discussed.

To determine the best method for solving the East Creek flooding problem, the Corps will organize the available information concerning several plans discussed at the workshop. A strategy meeting will be held with city officials to select an East Creek plan. The selected plan will then be analyzed and designed for the Phase I report scheduled later this year. The East Creek plan will be combined with the proposed levee upgrade and Chaska Creek diversion.

RECREATION DEVELOPMENT

At the workshop, it became apparent that the design and cost of recreational features of the plan were misunderstood. It was pointed out that recreation trail development in no way affects the amount of flood control necessary to protect Chaska.

Upon completion of the flood control study, the city of Chaska will have the option to decide whether it will participate as a cost sharing sponsor in the development of a trail. Cost sharing refers to the matching of Federal and local dollars to cover construction costs. The decision to share the costs of trail development is independent of the decision on flood control features such as a levee. Flood control is the primary project purpose, and recreational trail development will depend on the ability of the flood control project to accommodate the development, the need for the development, the economic feasibility of the development, and the city's willingness to finance the non-Federal cost of such recreation facilities.

ENVIRONMENTAL CONCERNS WORK GROUP

Some concern was expressed during the workshop that the analysis of environmental issues would slow the planning process. The objective of our planning process is to guide planning for the conservation, development, and management of water and related land resources. Environmental planning associated with the Chaska flood control study is an integral part of the planning process and is conducted concurrently with all other portions of the study.

During the planning process, we will be evaluating effects on resources, such as cultural resources, endangered species, water quality and wetlands, as required by law or Presidential Executive Order. Other environmental issues to be addressed are identified through coordination with other government agencies or through public workshops or meetings in the study area. The primary purpose of this coordination is to limit the environmental issues to be analyzed to those determined to be significant. Information gathered at public workshops and meetings is used to help identify significant environmental issues.

DO YOU HAVE ANY COMMENTS ?

If you have any comments concerning the project in general, or if you have any ideas for solving the East Creek flood problem, please write to us.

District Engineer
St. Paul District
U.S. Army Corps of Engineers
ATTN: Advance Planning Section, Planning Branch
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
411 Lafayette Road, Space Center Bldg., St. Paul, MN 55101
612/296-1800

August 15, 1980

Colonel William W. Badger
St. Paul District Engineer
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

CHASKA FLOOD CONTROL PROJECT

Thank you for the opportunity to comment on the alternative levee alignments and interior drainage proposals for the project at Chaska, Minnesota. On July 23, 1980 several of my staff met with Herb Nelson, the study manager for the Chaska project, to discuss the proposal in more detail than was provided in the information attached to your June 23, 1980 letter. The meeting helped to clarify the interior drainage proposals associated with the two alternative levee alignments.

Since both of the alternative levee alignments provide a similar degree of protection to the citizens of Chaska, our primary remaining concern relates to effects on Court House Lake. As you may know, Court House Lake is a former quarry pit that was reclaimed with fish toxicants in 1967 and is currently being managed for trout. As a designated trout lake, Court House Lake is a very unique and valuable resource in this part of the State.

Your staff indicated that Court House Lake is currently inundated by the 20 year flood event, and that levee alignment 2 would protect the lake up to the 100 year flood event. This increased level of flood protection is a highly desirable aspect of managing Court House Lake for a trout fishery since it would prevent warm water fish species from migrating into the lake during periods of inundation by Minnesota River flood waters. Such an influx of several warm water fish species into Court House Lake has occurred at least once since reclamation in 1967.

Even though Court House Lake will receive additional flood protection as a result of the authorized project, the possibility of utilizing Court House Lake as an emergency ponding area for the interior drainage system is a source of concern because no data exist on other possible adverse impacts in addition to the effects from the migration of warm water fish species to the lake.

It is my understanding that Court House Lake would be used as an emergency ponding area only for 100+ year precipitation events under full watershed development conditions. It is also my understanding that the lake would not receive first-flush runoff, and would only receive water that has been standing for several days so that the sediment and other materials will have a chance to settle out. In spite of these facts, it is still unknown how the impacts

of the possible use of Court House Lake as a ponding area might affect the lake. A related concern is that the quality of the runoff under full watershed development conditions may be significantly lower than under current development conditions. Any actions that can be taken to further minimize the use of Court House Lake or to improve the quality of the runoff from the watershed would be highly desirable. The use of portable pumping units of sufficient capacity should also be a recommended feature of the Court House Lake protection plan to further minimize potential ponding impacts. The areas needed for ponding under this proposal should be purchased or easements should be acquired. If necessary, the current flood plain zoning ordinance should be modified in the remaining areas along East Creek and Chaska Creek that will still be subject to periodic flooding.

My staff has also pointed out that the levee will pass through a wetland area just south of Court House Lake. This wetland is not at this time included in the inventory of Public Waters and Wetlands and is thus not subject to DNR permit requirements, but care should be taken to minimize the impact of levee construction and excavated material disposal on the wetland area.

As with other projects of this type, any actions affecting the course, current or cross-section of a public water body will require a permit from the Department of Natural Resources, Division of Waters. The permit application is the responsibility of the local sponsor and the permit is needed before any construction affecting a public water body can begin. Kent Lokkesmoe, Metropolitan Region Hydrologist, should be contacted at 296-7523 for details about permitting requirements.

To summarize, levee alignment 2 and the associated interior drainage facilities appears to be the best alternative at this time. This alternative provides protection for the citizens of Chaska, provides 100-year protection for Court House Lake, and would not require the removal of homes to establish adequate ponding areas. Any measures that can be taken to further reduce any potential adverse impacts on Court House Lake would be desirable. I look forward to continued cooperation with you as this project proceeds. If you have any further questions on the project, please contact Mr. Joseph Gibson at 296-0438.

Yours truly,

Joseph N. Alexander
Commissioner

JNA/JG:ph

cc: Larry Seymour
Chuck Burrows
Karen Loechler

NCSED-PB

Minnesota River at Chaska, MN. Phase I GDM; Meeting with City Staff

Memo for Record

Planning Branch
Engineering Division

18 March 1981

1. On 17 March 1981, Mr. David Haumersen ED-PB and I met with the following city staff members:
   - Mr. William Radio, City Administrator
   - Mr. Luke Melchert, City Attorney
   - Mr. Jim Olson, City Engineer
   - Mr. Kermit Crouch, City Planner
   - Mr. Gary Staber, Building Inspector
   - Ms. Shirley Brewers, City Clerk
   - Mr. Don Fahey, Supt. Public Works

2. Our main purpose was to present the newest design of the authorized project features. The following comments were received:

   a. East Creek diversion: The new southerly channel route above Highway 212 fits better with planned development and disrupts fewer existing improvements according to the planner. The engineer expressed strong support for the tunnel concept, compared to the previous open channel.

   b. Chaska Creek diversion: The city is concerned about project real estate interests between Highway 212 and Hickory Street. New design discharges are higher than the feasibility version so the channel is bigger and has longer curve radii. Several private bus barns will be affected and the business may need to relocate. An attempt will be made in Phase II to compare the cost of a concrete lined channel with the cost of relocating the business. The city may find some use for the buildings if the business relocates. A tunnel concept for Chaska Creek did not receive much interest. The engineer did ask whether part of the authorized alignment could be covered to allow continued use of existing improvements. The Phase II design work would better answer this question.

   c. Minnesota River levee: No significant comments or questions.

3. The late stage public meeting will be held 6 May 1981. The city administrator would like a premeeting with the city council on 4 May 1981 to discuss what will happen at the public meeting and what the city's official comments might be.

HERBERT A. NELSON
Civil Engineer
Planning Branch
Engineering Division

PUBLIC MEETING

FLOOD CONTROL

PURPOSE — TO PRESENT FINDINGS OF PLANNING FOR THE AUTHORIZED CHASKA PROJECT, AND TO OBTAIN YOUR VIEWS ON THE PROJECT.

WHEN? — WEDNESDAY EVENING
6 MAY 1981
7:30 P.M.

WHERE? — CARVER-SCOTT COOPERATIVE CENTER
(FORMER JUNIOR HIGH SCHOOL)
401 EAST FOURTH STREET
CHASKA, MINNESOTA

WHO IS INVITED? — ALL CONCERNED CITIZENS, GROUPS AND AGENCIES

DEPARTMENT OF THE ARMY
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

NCSED-PB

March 1981

You are invited to attend a public meeting concerning the proposed project of the U.S. Army Corps of Engineers for reducing flood damages in the city of Chaska, Minnesota. The purpose of this meeting is to ensure that all interested parties have sufficient information to understand how their concerns are affected by water resource problems and to give local interests the opportunity to express their views regarding the selected plan.

The project was formulated in an interim survey study by the Corps of Engineers following the floods in 1965 and 1969. In 1973 we submitted a report to Congress recommending: (1) improvements of the existing Minnesota River levee at Chaska, (2) diversion of East Creek flood flows and (3) diversion of Chaska Creek. This project was authorized by Congress in the Water Resources Development Act of 1976, and funds were provided in December of 1978 to initiate preconstruction planning.

This first phase of preconstruction planning was intended to affirm that the plan authorized by Congress, or a modification of this plan, reflects current public desires and meets current standards for national economic efficiency, environmental quality, regional development, and social well-being. Throughout the phase I studies, we met with city officials to keep local interests informed of study progress and ensure that local views were reflected in the project evaluation. Fifteen other distinct plans were reviewed including no action, five nonstructural alternatives, and ten structural alternatives.

Plan selection studies based on evaluation of these alternatives and coordination with the city officials indicate that the Chaska flood control project, as authorized by Congress, with modifications, represents the best solution to the flood problems of the city.

The recommended plan consists of: (1) upgrading the existing levee and extending the levee around the east side of Courthouse Lake to include the lake area in the levee's interior, (2) permanently diverting Chaska Creek, (3) diverting East Creek flood flows to the Minnesota River, (4) regulating the floodplain of remaining flooded areas, and (5) establishing a recreational trail system along the top of the levee and around Courthouse Lake.

All interested parties are invited and urged to be present or represented at this meeting, including representatives of Federal and non-Federal public agencies; agricultural, commercial, industrial, business, transportation, and utilities interests; civic, ecological and environmental, boating, recreation, and fish and wildlife organizations; and interested or concerned citizens, property owners, and others. All parties will be given the opportunity to express their views and furnish specific data on matters

pertinent to the study, including technical, economic, and ecological and environmental material. These statements, both oral and written, will become part of the official written record on this study and will be made available for public examination. If possible and for accuracy of record, important facts and statements should be submitted in writing. Those who are not able to attend the meeting may mail their statements beforehand to the Corps of Engineers address in the letterhead.

Please bring this announcement to the attention of anyone you know who is interested in this matter.

Wm W Badger

WILLIAM W. BADGER
Colonel, Corps of Engineers
District Engineer

1 Incl
1. Description of the
   authorized project

DESCRIPTION OF THE AUTHORIZED FLOOD CONTROL PROJECT

CHASKA, MINNESOTA

With passage of the Water Resources Development Act of 1976 (Public Law 94-587), Congress authorized the Chaska flood control project. As approved, the project includes a variety of measures to reduce flood damages on the Minnesota River, East Creek, and Chaska (West) Creek. The project also includes a number of recreational features to enhance the recreation opportunities in the area. The attached maps shows the general locations of the authorized flood control works as evaluated in the phase I studies.

LEVEE

The existing levee built by the city will be improved and extended to protect Chaska from Minnesota River flooding. The principal features of the work are:

- About 6,000 feet of upgraded levee (city levee).
- About 3,200 feet of new levee extending around the east side of Courthouse Lake. This would protect the lake from Minnesota River flooding.
- One pumping station and four ponding areas.
- About 5,000 feet of stormwater interceptor sewers.
- A relief well system for the seepage problem.

EAST CREEK DIVERSION

The proposed channel would divert excess flood flows around the east side of the city directly to the Minnesota River. The channel would enter a tunnel at U.S. Highway 212, going under the railroad yard, Stoughton Avenue, and the mobile home park located below Stoughton Avenue. The tunnel would exit in the floodplain wetland area just below the mobile home park. (See the attached map.) Under normal flow conditions, water will continue to flow through the natural creek channel through town.

CHASKA CREEK DIVERSION

The proposed Chaska Creek diversion channel would safely carry Chaska Creek floodwaters through the industrial zone on the west side of Chaska to the Minnesota River floodplain. The existing channel in this reach would carry local runoff only.

FLOODPLAIN REGULATION

Ponding areas and remaining unprotected portions of the river and creek floodplains would be subject to floodplain regulation to prevent damage to future development.

RECREATION

The authorized project calls for about $1\frac{1}{2}$ miles of paved recreation trails on top of the levee and around Courthouse Lake. These trails would complement the open-space stream corridor system being considered by Chaska and could be connected to the Minnesota River valley trail system being developed by the Minnesota Department of Natural Resources.

FLOOD CONTROL STUDY STATUS

The St. Paul District, Corps of Engineers, has completed the technical studies for phase I of the flood control study for Chaska, Minnesota. The recommended plan is based on information updated from the 1973 feasibility study and more detailed engineering studies. The plan will be submitted to the Corps' North Central Division for approval in August 1981. Before this submittal, the views of the local people and interested government agencies will be gathered at a public meeting.

PUBLIC MEETING

The public meeting to obtain your views has been scheduled for 7:30 p.m., Wednesday, May 6, 1981, at the Carver-Scott Cooperative Center. Colonel William Badger, District Engineer, and Mayor Tracy Swanson will moderate the meeting.

The agenda will include a slide presentation by the Corps of Engineers project manager Herb Nelson and a public response time moderated by Colonel Badger.

Your views will play an important part in shaping the final outcome of the project.

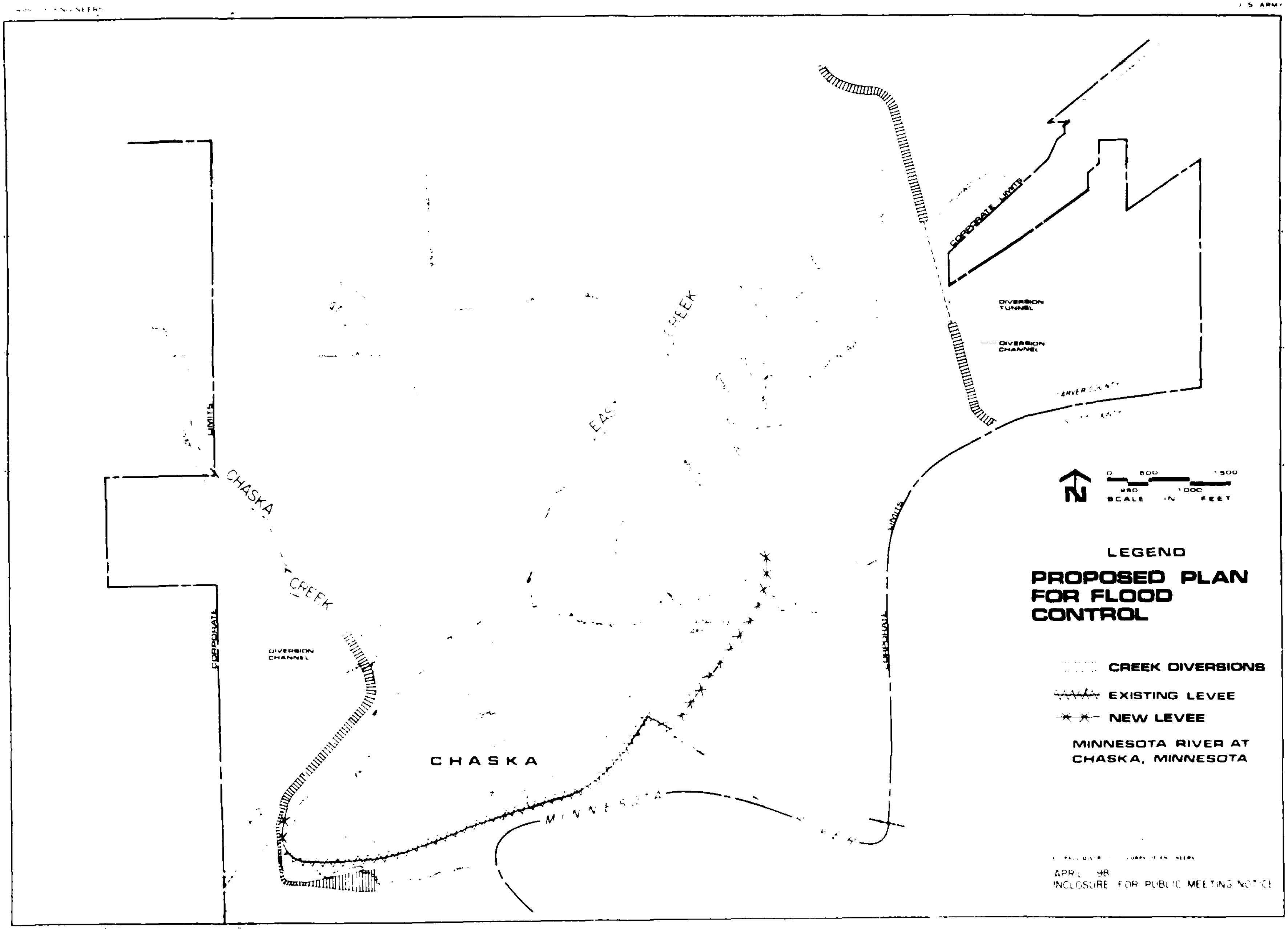
LEVEE AND DIVERSION LOCATIONS

The location and design of the levee and creek improvements were worked out only in enough detail for the planning done in this stage of the study - these locations are not final. However, we expect the alignments will stay as recommended unless there is a good reason to change them. There is always a possibility that new information or technical problems could cause a design change.

OTHER ALTERNATIVES

Early in this study, we reviewed 14 other flood control plans for Chaska. It was decided that the rest of the study effort would be concentrated on more detailed study of the authorized plan. The other 14 plans did not sufficiently meet the planning criteria to warrant further study. Information about the other plans will be available at the meeting or can be obtained by writing to:

St. Paul District, Corps of Engineers
ATTN: Planning Branch
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101


DIVERSION TUNNEL
DIVERSION CHANNEL
CORPORATE LIMITS
CARVER COUNTY
EAST CREEK
CHASKA CREEK
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PROPOSED PLAN FOR FLOOD CONTROL
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EXISTING LEVEE
NEW LEVEE
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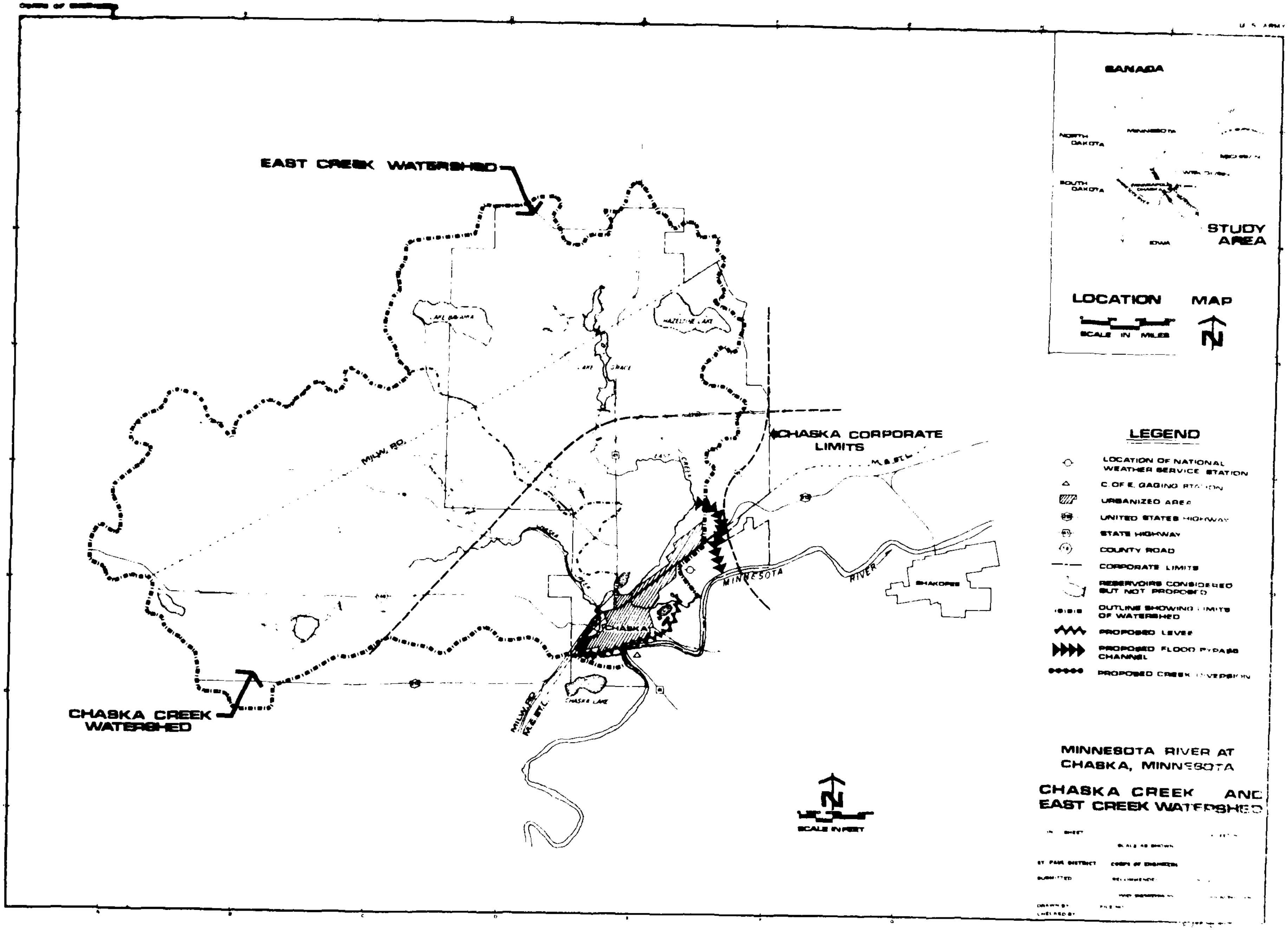
INCLOSURE FOR PUBLIC MEETING NOTICE


EAST CREEK WATERSHED
CHASKA CREEK WATERSHED
CHASKA CORPORATE LIMITS
MINNESOTA
RIVER
CHASKA
SHAKOPEE
CHASKA LAKE
HAZELTINE LAKE
LAKE GRACE
MILW. RD.
M. & STL.
SCALE IN FEET
CANADA
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
MICHIGAN
WISCONSIN
IOWA
STUDY AREA
LOCATION MAP
SCALE IN MILES
LEGEND
LOCATION OF NATIONAL WEATHER SERVICE STATION
C. OF E. GAGING STATION
URBANIZED AREA
UNITED STATES HIGHWAY
STATE HIGHWAY
COUNTY ROAD
CORPORATE LIMITS
RESERVOIRS CONSIDERED BUT NOT PROPOSED
OUTLINE SHOWING LIMITS OF WATERSHED
PROPOSED LEVEE
PROPOSED FLOOD BYPASS CHANNEL
PROPOSED CREEK DIVERSION
MINNESOTA RIVER AT CHASKA, MINNESOTA
CHASKA CREEK AND EAST CREEK WATERSHED
SCALE AS SHOWN
ST. PAUL DISTRICT
CORPS OF ENGINEERS
SUBMITTED
RECOMMENDED
DRAWN BY
CHECKED BY
U.S. ARMY

Flood control project is hearing topic

The district Army Corps of Engineers has scheduled a public meeting for Wednesday, May 6, 7:30 p.m., concerning the proposed flood control project for Chaska.

The purpose of the meeting is to present findings of planning for the authorized Chaska project and to obtain citizens views of the project, according to William Badger, district engineer.

The recommended plan consists of: upgrading the existing dike and extending it around the east side of Courthouse Lake, permanently diverting Chaska's West Creek, diverting East Creek flood flows to the Minnesota River, regulating the floodplain of remaining flooded areas, and establishing a recreational trail system along the top of the dike around Courthouse Lake.

The project was formulated in an interim survey study by the Corps of Engineers following the floods in 1965 and 1969. In 1973 the Corps submitted a report to Congress recommending: improvements of the existing Minnesota River levee at Chaska, diversion of East Creek flood flows and diversion of the West Creek. This project was authorized by Congress in the Water Resources Development Act of 1976, and funds were provided in December of 1978 to initiate preconstruction planning.

The first phase of preconstruction planning was intended to affirm that the plan authorized by Congress, or a modification of this plan, reflects current public desires and meets current standards for national economic efficiency, environmental quality, and regional development. Throughout the phase I studies, the Corps met with city officials to keep local interests informed of study progress and ensure that local views were reflected in the project evaluation.

Plan selection studies based on evaluation of these alternatives and coordination with the city officials indicate that the Chaska flood control project, as authorized by Congress, with modifications, represents the best solution to the flood problems of the city, according to Badger.

Next Wednesday's meeting will be held at the Carver-Scott Cooperative Center, 401 E. 4th St.

Appeared in Carver County Herald on 29 April 1981. The Herald is a weekly newspaper distributed in Chaska, Minnesota.

FLOOD CONTROL

PUBLIC MEETING

PURPOSE ? Present Recommended Flood Control Project & Accept Public Statements

WHEN ? Wednesday, May 6, 1981
7:30 P.M.

WHERE ? Carver-Scott Coop Center
(former junior high)
Auditorium
401 East Fourth Street
Chaska, Minnesota

WHO ? All Concerned Citizens, Groups & Agencies

COSPONSORED BY:
City of Chaska
St. Paul District,
Army Corps of Engineers

For More Information Call · 725-7472

This advertisement was inserted twice in the Carver County Herald.

First Insertion 29 April 1981

Second Insertion 6 May 1981

MEETING - CHASKA, MINNESOTA

NAME	POSITION	ADDRESS
Gary J. Wege	U.S. Fish & Wildlife Service	729 Holly Avenue St. Paul Park, MN 55071
Paul Schneider	MN Valley National Wildlife Refuge	4101 E. 78th Street Bloomington, MN 55420
John P. Taylor	USFWS	4101 E. 78th Street Bloomington, MN 55420
John L. Stine	MN DNR - Metro Region Waters	1200 Warner Road St. Paul, Minnesota 55106
Wallace Ess	Carver County Commissioner	217 Walnut Street Chaska, Minnesota 55318
Bill Weckman	Carver County Public Works	600 East 4th Street Carver County Courthouse Chaska, Minnesota 55318
Tracy Swanson	Chaska Mayor	
Milo H. Born	Chaska City Council	119 Elm Street Chaska, Minnesota 55318
Carl H. Griep	City Council	219 Ash Street Chaska, Minnesota 55318
Penny Tarkell	Planning Commission	523 Maple Street Chaska, Minnesota 55318
Paul A. Zoschke	Chaska Planning Commission	110312 Center Green Chaska, Minnesota 55318
Luke Melchert	City of Chaska (Attorney)	P.O. Box 67 Chaska, Minnesota 55318
Cy Ess	Chaska Flood Control	115 S. Elm Chaska, Minnesota 55318
Allen and Joyce Brakemeier	Riverview Terrace Mobile Home Park (owners)	302 Walnut Street Chaska, Minnesota 55318
Richard Salden	Salden School Bus Service (owner)	402 West 6th Street Chaska, Minnesota 55318
Dorothy Behrns	Citizen	316 East 2nd Street Chaska, Minnesota 55318
Elinor Behrns	Citizen	316 East 2nd Street Chaska, Minnesota 55318

NAME	POSITION	ADDRESS
Jerry Bielke	Citizen	100 Oak Street Chaska, Minnesota 55318
Alfred Blake	Citizen	120 South Chestnut Chaska, Minnesota 55318
Laura Blake	Citizen	120 South Chestnut Chaska, Minnesota 55318
Phyllis Bruhn	Citizen	520 E. 5th Street Chaska, Minnesota 55318
Hugh Cameron	Citizen	109 Maple Street Chaska, Minnesota 55318
Mrs. Elaine Dressen	Citizen	115 Ash Street Chaska, Minnesota 55318
Don Fahey	City of Chaska	205 E. 4th Street Chaska, Minnesota 55318
Charles E. Gilles	Citizen	633 W. 1st Street Chaska, Minnesota 55318
Bud Joseph	Citizen	115 Pine Street Chaska, Minnesota 55318
Mr. & Mrs. John Lithin	Citizens	634 E. 6th Street Chaska, Minnesota 55318
Paul J. May	Citizen	503 Beech Street Chaska, Minnesota 55318
John Naymovitz	Citizen	108 Cedar Street Chaska, Minnesota 55318
Gilbert Neutgens	Citizen	109 S. Elm Street Chaska, Minnesota 55318
Mrs. W. Parl	Citizen	312 Hickory Chaska, Minnesota 55318
Jean L. Poppler	Citizen	616 Willow Street Chaska, Minnesota 55318
Earl R. Schlefsky	Citizen	221 East 3rd Street Chaska, Minnesota 55318
Jim Schleicher	Citizen	620 Willow Street Chaska, Minnesota 55318

NAME	POSITION	ADDRESS
Caspar A. Schmitt	Citizen	416 W. 2nd Street Chaska, Minnesota 55318
Paul Schneider	Citizen	207 Ash Street Chaska, Minnesota 55318
Charles J. Stacken	Citizen	310 Maple Street Chaska, Minnesota 55318
Henry Therres	Citizen	506 E. 4th Street Chaska, Minnesota 55318
Lee VanSloun	Citizen	216 Ash Street Chaska, Minnesota 55318
Mrs. Reuben Welter	Citizen	640 E. 6th Street Chaska, Minnesota 55318
Tom Welter	Citizen	640 E. 6th Street Chaska, Minnesota 55318
M. T. Wiley	Citizen	307 E. 6th Street Chaska, Minnesota 55318

PROCEEDINGS

Public Meeting Transcript
Chaska Flood Control Project
Minnestoa River at Chaska, Minnesota

MAYOR SWANSON: I'd like to welcome you all. We can get started. It's 7:30. I'd like to welcome you all to another in a series of public meetings that we have had concerning the proposed project to protect Chaska against flood damage. The Army Corps has been working on this for several years. And during these years, we have had an opportunity as local citizens to give our ideas, to have local input into the plan into the project. This is another time - this is antother opportunity for those of us who live here to be able to say what we feel about this project - to give our ideas and our opinions.

I'd like to thank the Corps for keeping us informed as they are moving along through this process.

I would like now to introduce to you Major McKee of the Army Corps. He is executive officer with the St. Paul District. Major McKee -

MAJOR MCKEE: Thank you, Mayor, Good evening, ladies and gentlemen. We appreciate the opportunity to come here and to have you in attendance, because it's extremely important that we do have cooperation and input of your ideas and suggestions from the public as we progress through these studies.

I'd like to introduce the others here form the Corps. On my immediate right, Dave Haumersen, is Chief of the Advanced Planning Section. And Herb Nelson, most of you know, is the project manager - has been since 1978. And those of you who have attended, I'm sure have either spoken with him or presented your ideas along the way. In the back, we have Jeannie Wagner from our environmental branch.

If there is anyone who did not fill out an attendance card, we would appreciate having you do that. Also, when you filled out your attendance card, you had the opportunity to indicate whether or not you would like to speak and present an opinion at tonight's meeting. If you still have your card or did not indicate your desire to speak and would like to do so, if you sould pass that information to Jeannie. She'll see that we get it.

The objective of the meeting is to present to you our recommended solution to the problem, and the solution that we will forward to the North Central Division Engineer in Chicago, who will have the approval authority for the proposed project. I might indicate that a significant portion of the recommended solution came a suggestion from someone who attended one of our prior meetings. So, it does help. We do take your

suggestions, and try to incorporate those that provide the greatest benefits. So that you will have an understanding of what the proposal is, Herb Nelson will now give you a brief slide presentation of the proposal.

MR. NELSON: Early in this study, we determined that the authorized levee improvement was still the most likely flood control plan for Chaska. We checked the feasibility of the features of that plan, and we have made some changes in the design and some of the locations of the features. The changes were made because of techinical considerations or because of public concerns.

I have a short slide presentation to show you. And it shows the most current design and locations are based on feasibility-level information and may be subject to minor changes in the future. However, unless there's a good reason to change the design, the project is expected to remain essentially the same as shown tonight. If we can cut the lights now, I'll show some slides that should help locate the features.

In 1952, the City of Chaska constructed a levee for controlling floods from the Minnesota River. In 1969, the Levee was raised two feet by the Corps of Engineers during Operation Foresight. The City has also done work to the levee. The levee has some design problems, because a portion of it was constructed under emergency conditions. A logical approach for permanent flood control is to correct the design problems and upgrade the existing levee.

We are proposing that the Federal Government participate in a project to upgrade and extend Chaska levee, shown in yellow. The biggest design improvement, shown in red, is to divert Chaska Creek and East Creek around the outside of the levee so that creek flood waters can not build up on the city side of the levee.

Next slide, please. The Minnesota River levee protects a major portion of the older residential areas of Chaska. The existing levee has problems, including interior flooding from the two creeks, seepage, ereion and steep side slopes.

Next slide. We propose that the top of the levee be raised about two feet. Soil would be added on top of the levee and on the sides of the levee to strengthen it. The orange lines show what the top and side slopes might look like after construction. Wherever possible, the design calls for the additional soil being placed on the river side of the levee as compared to the inside of the levee. With the recommended levee alignment, we expect that two homes and three garages would need to be relocated before the levee could be constructed.

The proposed location of the levee is shown in purple on this slide. The alignment follows the existing levee, except in the area near Carver County Courthouse. The yellow line indicates the existing levee near the courthouse. We propose that the levee be oonstructed to the east of the Courthouse Lake. This location is cheaper because it provides sufficient area for interior drainage ponding without a pumping station. This location also protects the trout fishery in Courthouse Lake from flooding and prevents the introduction of rough fish from the Minnesota River.

The light blue area on this slide identifies the flood plain of East and Chaska Creeks behind the existing levee. We propose to divert Chaska Creek and East Creek around the levee to prevent this type of flooding.

The Chaska Creek diversion channel is shown in green. The new channel will remove all creek flows from the existing channel between U.S. Highway 212 and First Street.

This is the existing channel which would no longer carry Chaska Creek flows. The channel will be necessary for draining local rainfall runoff. This part of the existing channel would not be filled in by the project.

The East Creek diversion consists of a tunnel and open channel. The tunnel portion is located between U.S. Highway 212 and an area below the Valley View Mobile Home Park. The open channel begins near the covered Brandondale Bridge, goes under County Road 17, and down to the entrance to the tunnel at Highway 212. There is also a section of open channel from the tunnel exit to the river.

The dashed red line represents the approximate location of the tunnel. The tunnel exit is visible to the far right, just below the street level. It is likely that one row of mobile homes would be temporarily relocated during construction. After construction, the mobile homes could be returned to their original location. The City would provide an interim location for the homes. Construction of the tunnel will not distrub the existing inprovements on the north side of Stoughton Avenue.

The diversion channel begins in this area. The existing channel is shown in blue. The outline of the diversion is shown in red. Normal flows would be diverted into the project channel, shown in red.

The proposed project also includes a recreational trail system along the top of the levee and around Courthouse Lake. The trail is designed to be used with the trail system bing planned by the Minnesota Department of National Resources.

That concludes the slide presentation. Now, I'd like to return the meeting to Major McKee.

MAJOR MCKEE: Thank you, Herb. On the sign-in cards, there was no one who indicated a desire to speak formally. So, we'll pass that portion of the meeting and go to questions and answers. If you want to ask a question, I would ask you to stand, state your name, and whether you're representing just yourself or an organization or a company. And then we'll do the best we can to field whatever questions you have. Are there any?

CY ESS: What would be a possible starting date on this thing if everything goes right? When can we start seeing some progress on this? We've been waiting for 16 years. I'd like to know if you've got something definite.

MR. HAUMERSEN: Well, it does take a long time. Things are progressing. And we're in what we call the advanced planning stage. The project is authorized by Congress for contruction; and the next stage of this is the detailed plans and specifications that would have to be done for the project. We anticipate with requirements that are, that we have that in order to get a construction start, it would be 1985 at the earliest. One thing is involved yet that's out of our hands, and that is the appropriation by Congress of construction funds. But if that comes in a normal or logical sequence, by 1985, we could see some construction.

MAJOR MCKEE: Are there other questions?

MILTON WILEY: When this is finished or started and completed, will it change the flood plain designation around the areas that are presently considered in the flood plain?

MAJOR MCKEE: Herb, you want to take that one?

HERB NELSON: The portion of the original community behind the levee would be removed; and I believe your're talking about the Minnesota Flood Plain Regulation Program. There would be a small residual area. However, none of the residual areas are where there are improvements. The residual areas would be for things such as interior drainage ponding, or in low-lying areas that is just not feasible to provide some type of a project feature. There are areas outside of the levee that are not going to be protected by the project, and those would continue in the present flood plain regulation program. There are no areas along the creeks above the blufflines that are affected by the project. Below the blufflines in the East Creek area, there is a large area that would be removed; and there is a residual area there. So, between the Minnesota River and East Creek floodplains, there will be few improvements that would be in a residual flood plain.

MILTON WILEY: You mentioned that the West (Chaska) Creek would continue to be in existence for internal drainage. How about the East Creek?

HERB NELSON: The East Creek will remain in its existing state. Normal flows, the type that you see during the summer, but not during a rain storm, will continue in the existing creek. We don't wish to stop the flows in the East Creek because of the asthetics of it. It's a beautiful stream. Some of the areas there are fantastic. What we're doing is diverting the flows that are above a safe level down the diversion channel. We're just bypassing the dangerous portion of the flood and allowing normal types of flow and activity to happen along the creek.

LUKE MELCHERT: Luke Melchert, representing the City of Chaska. Am I correct if it's no longer subject to the flood plain regulation, people in lower Chaska or that were formally in the flood plain would not be required from the lending institution, to take out federal funds; is the correct?

MR. HAUMERSEN: Yes, that's correct.

LUKE MELCHERT: So that would have to be certified so there would not a requriement for funds. Okay.

MAJOR MCKEE: Are there any others? Yes, Ma'am.

PENNY TARBELL: You mentioned a possibility of the loss of one home and two garages; and what area would that be?

MAJOR MCKEE: Herb?

HERB NELSON: That is with the levee. And at this point in time, I can tell you the ones that we're looking at. The levee design has gone through a few iterations or stages of development. This isn't the final design, but it's what we expect, unless there's a big reason to change it. I want that to be clear. The garages that we're talking about and the homes are basically in the area where Highway 41 crosses the river where the bridge is at. It's very tight there. There's no room on the river side to place the fill without having the river just erode that work away. So, most of the fill has to come on the inside of the levee rather than the outside. Along that area, we also have some wells that we call seepage relief wells. There's a problem ther with the foundations where we have to have room to put these wells in there and relieve some underground water pressure problems in that area. Those also take some room. So, the combination of the levee plus those wells, makes it a very tight point along the levee.

MAJOR MCKEE: Yes, sir.

ALLEN BRAKEMEIER: Will the Riverview Terrace Mobile Home Park that's the area your're talking about going under (with the tunnel), under the homes; and it's my understanding then that these homes would be placed back on top of your culverts, or --

HERB NELSON: Yes, that's correct. The relocation would be only a temporaty one. The City would provide a place for the mobile homes.

during construction. A guesstimate or a rough estimate, would be something like a year during construction. It could be shorter, something shorter, but one construction season. The utilities, those types of things, would also be connected by the City. It would be a safe place for those mobile homes to be. When the construction was finished, they would be returned to their original location. And the actual exit for the tunnel is south of the street system there for that mobile home park. And it would exit well below where any of the homes are at. Safety is also an important factor. There'd be a fence system or other safety features similar to that, to prevent anyone from entering the tunnel or being injured there.

ALLEN BRAKEMEIER: We're also proposing an extensive playground, a softball field in that area. Do you have nay idea what, where you're proposing to put this tunnel in?

HERB NELSON: I've got some maps here that I could show you afterwards. They're a little bulky to be showing everyone. But we do have them available. If you'd like to see that, if you have a specific site you'd like to see. Also, that tunnel is not very deep. I'd just like to mention that it's only on the order of 15 to 20 feet deep through there. It's not a great hazard, by any means. It's a concrete structure that has to be constructed by opening a trench and laying it, and then filling it back. That's why the construction would require temporary relocation.

ALLEN BRAKEMEIER: Also, you're going to have to discontinue sewer and water. I would imagine electric, too.

HERB NELSON: Right. These things would also be taken care of. Any utilities that would be there, would be relocated so that they function the way they do now.

MAYOR SWANSON: Herb, why don't you go the West Creek, (Chaska Creek) and talk about any relocations there. I think that would be of interest.

HERB NELSON: Okay. The Chaska Creek diversion, the way it's presently designed, will require two homes north of U.S. Highway 212. This is an area where the creek winds through a group of about four or five homes. The two closest to the creek there are much too close to get a channel through without relocating them. The other relocation is a business. It's a group of four buildings that would have to be relocated, or a design, in our next stage of report, would have to be modified to try to go through that area without destroying the buildings or having them removed. Those are the only relocations of homes or businesses on the Chaska Creek diversion.

MAJOR MCKEE: Are there any other questions?

LEE VANSLOON: Lee Vansloon. You'd mentioned something about a ground water infiltration, or whatever. Wouldn't it be possible to bore holes in

the ground and pump concrete in to seal that water off, rather than sinking some wells into, like well points, I would assume you're talking, or --

HERB NELSON: The problem is that you have two layers of material down there, soil of some type, that is trapping a layer of sand or gravel. The water comes in from the river, goes through that layer of sand or gravel, and then it finds someplace where it tries to come through the top layer. It'll either come in and collapse someon's basement, or it will heave the ground. The fear is that it will do some type of damage to the toe of the levee. You'll get a dangerous situation where the leveemight collapse with that. What you're trying to do is relieve the pressure in a controlled manner. You put the pipe down through that top layer of material, allow it to come throught the sand and gravel, pump it out someplace safe, over the levee and back into the river. The idea of letting a barrier down will sometimes work, but not in this case. It's much cheaper to put a few wells in there and pump it back.

LEE VANSLOON: Couldn't you do the same thing on a permanent basis, like pumping concrete down; I mean, I'm talking down, and bringing it up as a more permanent solution?

HERB NELSON: You're talking about a grout curtain. It is a type of feature that can be used. What we're talking about is maybe 800 to 1000 feet of grout curtain that would have to go along the toe of the levee. It's much too expensive. It's much easier to just put shallow wells in at specified distances and just pump it back.

MAJOR MCKEE: Are there any other questions? If not, I guess I'll turn it over to Mayor Swanson for any concluding remarks.

MAYOR SWANSON: I guess I'm surprised there aren't more questions. I thought maybe you'd have one back there, Rick.

RICK SALDEN: Pardon?

MAYOR SWANSON: Nothing's changed at all that you have to --

RICH SALDEN: Herb answered my questions before.

MAYOR SWANSON: I really had no comments. If there are more questions -- I think the people here are, Iwould think, very interested in the time schedule. I think the next step perhaps, will be in August. And I think if you explain that kind of a time schedule, I think we would like to know that. What's happening next, and that kind of thing?

HERB NELSON: The information that we have been gathering and putting together about these design changes (to the authorized project) will be put together into a report that we send to Chicago. that will go out in August. The Division Engineer will review it, make sure that we've taken everything into account, designed the project features under correct

criteria and hopefully approve it. Before he approves that, we may have to go through some small changes to make sure that everything's been taken care of. When the project is approved, be transferred to our design branch. At that point in time, they will begin doing plans and specifications, very detailed information, preparing for construction. The design branch is a branch in our organization that does the preparing and pre-construction work before it goes to our construction branch. We're talking about a short amount of time before we begin working on the plans and specifications for construction. It's not really that much time.

MAYOR SWANSON: You're conceivably looking to 1984 to see whether or not this is actually going to be funded by the Federal Government? Is that about the earliest we would find that out?

MR. HAUMERSEN: Well, it would have to go to the Water Resource Development Act for Congress to authorize or apportion the money. Generally, that's the way we get the money for the construction.

MAYOR SWANSON: You're saying probably two years?

MR. HAUMERSEN: It well be ready for their action, yes. At that point in time, that's when we need to get all the support we can of the Minnesota senators, the representatives, and the City - any pressure that can be brought about to get those funds. Once the funds start, that's the biggest hurdle. After they start, they keep coming until the construction is complete.

MAYOR SWANSON: Why do you feel this project will be funded when there are so many others? How is this project different form others that could conceivably be cut from the way things are going today?

MR. HAUMERSEN: There are many new starts that are applied for. Right now, the top priorities in the Federal Government are Hydro-power and urban flood control. Then several other below that. This one falls in the second catagory. If the Reagan administration should decide to get funds for construction and new starts, I suspect this would be one of the first ones.

MR. MELCHERT: You'll be monitoring when it gets to Washington, and notify us when to do our PR and earning our support out there?

MAYOR SWANSON: Yes, absolutely.

MR. HAUMERSEN: When this project gets transferred to the design branch there will be another gentleman that will be what they call project manager. The design project manager will then take over. There won't be near as much public involvement, because he will have to coordinate it to make sure that we're doing what the public wants and the City wants. So, the design project manager will work closely with the City Engineer and the staff there

to make sure that the City knows exactly what it needs to get the project implemented as soon as possible. Once it gets in that stage, however, it doesn't hurt at all for the City, I'm sure the Corps of Engineers' office knows that they're very anxious to get on with it.

MAJOR MCKEE: If there are no more questions, we'll bring the meeting to a close. Herb mentioned that he does have -- Yes, ma'am.

ELAINE DRESSEN: I was just wondering what's the length of time that the construction would take? Do you anticipate a certain amount of time?

HERB NELSON: What we expect is a two-year program for construction. That's what we show in the program right now. We'd be doing the creeks first, because they present the greatest damage potential by coming down behind the levees. In the second year we'd do the levee. One problem with the levee first is that the creeks could come down and destroy the work that's already been done, if the situation occured where you'd have a heavy rainstorm. It's possible that our workload could at the time, take just one year to do the construction. But we're showing it at two years, because that's what normally would be done now.

MAJOR MCKEE: Yes, sir.

ALLEN BRAKEMEIER: Is there funding available for the design?

MR. HAUMERSEN: Yes. The funding will continue to come until the design and specifications are completed.

MAJOR MCKEE: If there are no additional questions, we'll call the meeting to a close. I would remind you that we do have drawings down here, if you would like to look at them. If there are other informal questions you'd like to ask, we'll be here for awhile. Thank you very much for coming. We certainly will need your support to continue through to construction.

Chaska

WILLIAM M. RADIO
City Administrator

May 7, 1981

Department of the Army
St. Paul District
Corps of Engineers
District Engineer
1135 U.S. Post Office and
Custom House
St. Paul, MN. 55101

Dear Sirs:

After completing a preliminary meeting with representatives of the Corps of Engineers and having attended and heard the comments of the affected property owners in Chaska at the Corps public hearing of May 6, 1981, we are pleased to express our support for the Corps project for the Minnesota River at Chaska, including improvement of the East and West Chaska Creeks.

We understand that the project has been approved for construction by Congress with funding considerations to be made at the appropriate time. The present estimated cost of the project is approximately 16 million dollars with 3 million dollars of that to be the approximate share expected to be produced by the City.

Our only concern with the project is our understanding that 1985 would be the soonest construction could begin. We would like to emphasize to you that our support for the project is based upon the need within the City and that anything that can be done to expedite the timing of the project would be supported and greatly appreciated by us.

Thank you for your efforts on behalf of our citizens.

Sincerely,

Tracy D. Swanson

Tracy D. Swanson
Mayor, City of Chaska

TDS:jw

City Of Chaska Minnesota 205 East Fourth Street 55318 Phone 612-448-2851

COMMENTS ON THE APRIL 1982 DRAFT REPORT

The following pages contain correspondence on the April 1982 draft report. Letters providing specific comments on the report are followed by Corps responses.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSPD-PF

7 May 1982

The Draft Phase I General Design Memorandum and Draft Supplement to the Final Environmental Impact Statement (EIS) for the Minnesota River at Chaska, Minnesota, has been completed.

The draft report and EIS supplement is being sent to the Environmental Protection Agency. When a notice of availability appears in the Federal Register, an official 45-day review period for the draft EIS supplement will begin. This period should expire in June 1982. All interested parties are invited to submit their comments on the report to the District Engineer during the review period. The District office will respond to any comments received on this document.

The draft report recommends a combination of improvements for the Minnesota River levee and diversion of upstream creek flows around the levee directly to the Minnesota River.

The report is available at the St. Paul District office and the following libraries:

Chaska Public Library
314 Walnut
Chaska, Minnesota 55318

St. Paul Public Library
Document Collection
90 West 4th Street
St. Paul, Minnesota 55102

Minneapolis Public Library
Documents Division
300 Nicollet Mall
Minneapolis, Minnesota 55401

University of Minnesota Library
Government Publications Division
409 Wilson Street
Minneapolis, Minnesota 55455

Additional copies of the report can be obtained by contacting study manager Ed Fick at (612) 725-7577.

Sincerely,

William W. Badger

WILLIAM W. BADGER
Colonel, Corps of Engineers
District Engineer

1-95

Various other candidates.

Commissioner for Energy
Dept. of Energy, Planning
and Development
980 E. Kellogg Blvd., Rm. 740
St. Paul, MN 55101

President
Lower MN River Watershed Dist.
315 East Third Street
Chaska, Minnesota 55378

Acting Director
[illegible]
Department of Energy
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690 American Center Bldg.
150 E. Kellogg Blvd.
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District Manager
Association of American Railro.
111 East Franklin Avenue
Minneapolis, MN 55404

U.S. Forest Service
37 Reed Road
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Ms. Marilyn Lundberg
SMRBB
600 American Center Bldg.
St. Paul, Minn. 55101

Commander (dpl)
Second Coast Guard District
1430 Olive Street
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Honorable Robert Schmitz
Minnesota Senator
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St. Paul, Minnesota 55155

Ducks Unlimited
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St. Paul, MN 55117

Chief
[illegible] Basin Planning Branch
[illegible]
[illegible]
[illegible]

Honorable K. J. MacDonald
Minnesota Representative
328 State Office Building
St. Paul, Minnesota 55155

Friends of the Earth, MN Br.
P.O. Box 203
Aitkin, MN 56431

Director
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[illegible] Street
[illegible]

Water Res. & Coastal Cons. [illegible]
National Wildlife Federation
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[illegible] Devel. [illegible]
[illegible] Dept. of Commerce
[illegible] W. First St., Rm [illegible]
Duluth, MN [illegible]

North Midwest Representative
National Audubon Society
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Jamestown, ND [illegible]

The Waterways Journal
666 Security Building
819 North 4th Street
St. Louis, MO 63102

Federal Highway Admin.
[illegible] Dixie Highway
Homewood, IL [illegible]

National Audubon Society
North Midwest Region
Madison Office
142 W. Gorham Street
Madison, WI 53703

Izaak Walton League of Amer.
Suite [illegible]
[illegible] North Kent Street
Arlington, VA [illegible]

[illegible] Postmaster
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[illegible]

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Soil Cons. Society of Amer.
200 Fed. Bldg. & US Crthouse
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Division Superintendent
Midwestern Gas Transmission
P.O. Box 70
Wadena, MN 56482

North Central Reg. Exec.
Natl. Wildlife Federation
710 2nd Street NW
Mandan, ND 58554

Minn. Environ. Control Citi-
zens Association
P.O. Box 80089
St. Paul, MN 55108

MPIRG
2412 University Ave. SE
Minneapolis, MN 55414

Sierra Club, North Star Chap.
210 Lamar Bldg.
111 E. Franklin Avenue
Minneapolis, MN 55404

2

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U.S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:

[illegible] [illegible]

Inclosed is the Draft Phase I General Design Memorandum and Draft Supplement to the Final Environmental Impact Statement (EIS) for the Minnesota River at Chaska, Minnesota.

The draft report and EIS supplement is being sent to the Environmental Protection Agency. When a notice of availability appears in the Federal Register, an official [illegible]-day review period for the draft EIS supplement will begin. This period should expire in [illegible]. All interested parties are invited to submit their comments on the report to the District Engineer during this review period. The District office will respond to any comments received on this document.

The draft report recommends a combination of improvements for the Minnesota River levee and diversion of upstream creek flows around the levee directly to the Minnesota River.

Additional copies of the report can be obtained by contacting study manager [illegible] at [illegible] [illegible]-7577.

Sincerely,

WILLIAM W. BADGER
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Kaskaskia Phase I GDM

Federal

Mr. Harvey K. Nelson
Regional Director
U.S. Fish & Wildlife Serv.
Federal Bldg. - Fort Snelling
Twin Cities, MN 55111

Area Manager
Fish and Wildlife Service
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Regional Director
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Mr. Richard L. Friedman
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Asst. Director
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12201 Sunrise Valley Drive
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USGS, Conserv. Div.
Area Water Power
Box 25406, Mail Stop [illegible]
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Mr. Valdas Adamkus
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U.S. Environmental Protection Agency, 230 S. Dearborn St.
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Farmers Home Administration, USDA
252 Federal Building
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Mr. Harry M. Major
State Conservationist
Soil Conservation Service
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Mr. F. Dean Carlson
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Ann Arbor, MI 48107

Chief, Interagency Archaeological Services-Denver, NPS
655 Parfet St., Box 25287
Denver, CO 80225

Executive Director
Advisory Council on His. Pres.
1522 K Street N.W.
Washington, D.C. 20005

[illegible] on Env. Quality
EEC
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Washington, D.C. 20426

Deputy Asst. Sec. for Env. Affairs
U.S. Dept. of Commerce
Washington, D.C. 20230 (6)

Bureau of Indian Affairs
Mpls. Area Office
Chamber of Commerce Bldg.
15 South Fifth Street
Minneapolis, MN 55402 (2)

[illegible] Dept. of the Int.
[illegible] Office of Env. Proj. Rev.
Washington, D.C. 20240

Separate ltr to EPA (5 cys)

Chaska Phase I 60m

State

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State Historic Pres. Off.
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Christy A.H. Caine
State Archaeologist
Cass Lake, MN 56633

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Mr. Joseph Alexander
Commissioner, MN Dept. of
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Fish and Wildlife Division
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Executive Director
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Chairman, Metropolitan Coun.
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Minnesota Dept. of Agriculture
420 State Office Building
St. Paul, MN 55113

Dr. Richard Wade
Dir., Div. of Environmental
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Secretary and Executive Officer
Minnesota State Bd of Health
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Natural Res. & Agr. Comm.
State Capitol
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State House of Represent.
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Mr. Charles Kenow
Environmental Quality Board
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St. Paul, Minnesota 55101

Chaska Phase I GDM
Libraries, local, and misc.

Legislative Library
State Capitol
St. Paul, MN 55155

Minneapolis Public Library
Documents Division
300 Nicollet Mall
Minneapolis, MN 554[illegible]

University of Minn. Library
Government Publications Div.
409 Wilson Street
Minneapolis, MN 55455

Documents Librarian
Colorado State University
Fort Collins, CO [illegible]

St. Paul Public Library
Document Collection
[illegible] West 4th Street
St. Paul, MN [illegible]

Metropolitan Council Library
[illegible] Metro Square
St. Paul, MN [illegible]

[illegible] Reference Library
[illegible] Librarian
Fourth [illegible] Streets
St. Paul, MN [illegible]

Environmental Conservation
Library of Minnesota
[illegible] Nicollet Mall
[illegible]

University of Minnesota
Agricultural Library
St. Paul Campus
[illegible] Librarian
St. Paul, MN [illegible]

[illegible] Library
[illegible]

[illegible]
Mayor of Chaska
205 East Fourth Street
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Mr. William Radic
Chaska City Administrator
205 East Fourth Street
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Mr. Patrick Murphy
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Chaska, Minnesota 55318

Mr. Luke Melchert
Chaska City Attorney
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Mr. Jim Olson
City Engineer for Chaska
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& Associates, Inc.
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Roseville, MN 55113

Mr. Rodney Gordon
City of Chanhassen
City Offices
Chanhassen, MN 55317

H. Paul Friesema
TIE, H[illegible] Res. Bldg.
Butler University
Indianapolis, IN [illegible]

Chicago-Milwaukee Corporation
516 West Jackson Boulevard
Chicago, Illinois [illegible]

Metropolitan Waste Control Commission

May 17, 1982

Colonel William W. Badger
District Engineer
Department of the Army
St. Paul District Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, MN 55101

Re: Chaska Treatment Plant
Minnesota River Levee Improvements

Dear Colonel Badger:

The Commission has reviewed the Draft Phase I General Design Memorandum and Draft Supplement to the Final Environmental Impact Statement for the Minnesota River at Chaska, Minnesota.

It is noted that a planning constraint and objective for the recommended alternative (combination of improvements for the river levee and diversion of upstream creek flows) included flood protection of the Chaska Wastewater Treatment Plant and allowing space for potential expansion of the plant.

When available, the Commission should be provided with a copy of the plans and specification for these improvements. Also the Commission should be informed of any construction practices which potentially could interfere with the operation of the treatment plant.

If you have any questions, please contact the Commission.

Sincerely,

G. W. Lusher

George W. Lusher
Chief Administrator

GWL:PHD:hw

Corps Response

1. Noted: We will provide the requested information.

June 1, 1982

Metropolitan Council of the Twin Cities Area
300 Metro Square Building
Saint Paul, Minnesota 55101
Telephone 612/291-6359

Colonel William A. Badger
District Engieer
Corps of Engineers, St. Paul District
1135 U.S. Post Office and Customs House
St. Paul, MN 55101

ATTN: NCSPD-P

RE: Metropolitan Council Referral File No. 10541-1

Dear Colonel Badger:

Thank you for the opportunity to review the Draft Phase I General Design Memorandum (GDM) and Draft Supplement to the Final Environmental Impact Statement (EIS) for the Minnesota River at Chaska. The Metropolitan Council also commented on this project on Jan. 10, 1979 (Ref. File No. 7413-1).

The most significant area of concern is the lack of recognition in the GDM and support appendices for the reduced flows expected with implementation of the 1979 Chaska Storm Water Management Plan. The GDM refers to expected "substantial" storm water increases as the watersheds, particularly East Creek, develop. This is a very valid point since approximately 5,000 new housing units and numerous commercial/industrial and public developments will be built by the year 2000. As mentioned in our 1979 response, it would seem to be a good practice to require implementation of a watershed storm water management program as an integral part of federal participation in an expensive flood control project. We are confident that Chaska will use its plan, but the GDM shows that all of the storm water generated by the watershed can be handled by the project, thus seeming to negate the need for watershed level control. Our primary concern is that the quality of the watershed storm water will likely be poor if it is not managed prior to reaching the flood control project. A mention in your text of Chapter 509 of the 1982 Minnesota legislative session laws dealing with storm water control in the Metropolitan Area would reference the mandate for runoff management in the tributary area.

Along those lines, we would like to encourage you to pay particular attention to mitigating the impacts of the storm water as it enters the floodplain at very high velocities. The GDM and appendices report velocities for various elements of the project from 13-28 feet per second. Even if reduced substantially, these velocities can be quite destructive to earthen areas and can resuspend river deposits that are likely of poor quality.

We are quite pleased to see that Courthouse Lake will be used only for 1,000 year frequency flows. Our evaluation of the U.S. Geological Survey water quality study (Appendix 8) raised some concern. Having participated with USGS in the project that collected the Hwy. 100 runoff, it does not seem to us that the use of this data is valid for the Chaska area because of the significant

An Agency Created to Coordinate the Planning and Development of the Twin Cities Metropolitan Area Comprising:
Anoka County / Carver County / Dakota County / Hennepin County / Ramsey County / Scott County / Washington County

Colonel William A. Badger
Corps of Engineers, St. Paul District
June 1, 198[illegible]
Page Two

300 Metro Square Building
Saint Paul, Minnesota 55101
Telephone 612 291-6359

differences in land use and watershed topography. We are also concerned by the statements that the lake could "rebound" after having its total phosphorus concentration raised from 0.03 to 0.12 mg/l and its spring [illegible] trophic-state index from 49 to 69. Although we feel that these conclusions are founded on inappropriate data, we are still concerned with such a conclusion because our lakes studies show that changes similar to those indicated above do have significant impacts on lakes. Again, your elimination of [illegible] year flows and the parking lot runoff from the courthouse [illegible] a wise decision.

The GDM now also proposes to protect the wastewater treatment plant and allow for its expansion according to the Metropolitan Council's Water Resources Development Guide and the Metropolitan Waste Control Commission (MWCC) Development Program. The city should be alerted that the MWCC will look for land to the east of the existing facility behind the new levee.

From a transportation standpoint, the draft Council Transportation Policy Plan for the year 2000 no longer shows a relocated Trunk Hwy. 41 bridge. The plan instead shows a "major arterial" at the location of the existing Trunk Hwy. 41 bridge. Trunk Hwy. 212 is still proposed for relocation above the bluff.

Thank you for keeping us apprised of the Chaska project. Please let us know if we can be of further assistance.

Sincerely,

Charles R. Weaver
Chairman

CRW:sa

cc: William Sando, Metropolitan Council District 16
Gary Oberts, Metropolitan Council Staff

Corps Response

1. We agree that a watershed stormwater management plan would be a good practice but we cannot require a local sponsor to comply with restrictions established by State, regional, or local authorities which differ from Federal requirements.

2. Our proposed project will not increase the velocities of the stormwater flows in the creek areas and, therefore, resuspension of river deposits should not be any different than under present conditions.

3. Your concerns do not affect our future study but we suggest you contact the U.S. Gelogical Survey to resolve them.

4. Noted.

5. Noted.

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST
CHICAGO, ILLINOIS 60604

REPLY TO ATTENTION OF:

Colonel William W. Badger
District Engineer
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

10 JUN 1982

RE: NEPA-DS-COE-A36006-MN (82058)
Flood Control - Chaska,
Minnesota

Dear Colonel Badger:

The U.S. Environmental Protection Agency (USEPA) has reviewed the draft supplement to the final Environmental Impact Statement (EIS) for flood control on the Minnesota River at Chaska, Minnesota.

The proposed flood control project considered both non-structural and structural alternatives to reduce flood damages in the City of Chaska. The preferred alternative includes increasing the Minnesota River levee (both in height and length), improving interior drainage behind the levee, diverting East and Chaska Creeks, implementing floodplain regulations in unprotected areas, and providing recreational opportunities (mostly hiking trails) in conjunction with levee construction.

1 Because urbanization of floodplains is a land use incompatible with the land's capability to support that use, the U.S. EPA prefers the alternative of floodplain evacuation. We recognize that floodplain evacuation is expensive and not always socially acceptable; however, floodplain evacuation is environmentally protective. It is a long-term solution and restores the land to a use that it is capable of supporting. Restoration of the floodplain controls flooding at its source without affecting upstream and downstream areas. Thus, the environmentally preferrable alternative is floodplain evacuation.

2 The proposed structural alternative requires 21 acres of forested floodplain for levee construction and about 10,000 feet of creek channelization. These modifications will reduce the floodwater retention capacity of the Minnesota River floodplain in this area and flooding will be shifted elsewhere.

3 Additionally, channelization of East and Chaska Creeks will reduce their ability to assimulate pollutants carried into them by stormwater runoff. As stated in the EIS, these effects are expected to be minor because the loss of floodplain land is small and the aquatic ecosystem in the area is not particularly diverse or productive anyway.

We are rating the proposed project as LO-1. This means we lack objections (LO) to the project's environmental impact, and there

is sufficient information (1) in the EIS to evaluate the impact. We want to stress that construction in the floodplain, no matter how inconsequential it may seem on a project specific basis, is an incompatible land use and results in environmental deterioration. At the same time, however, we recognize that the proposed structural alternative, the preferred alternative, is designed to minimize its effect on the environment. Therefore, the project will not result in an unacceptable adverse environmental impact.

Our review is made pursuant to our responsibilities under the National Environmental Policy Act and Section 309 of the Clean Air Act. These authorities require us to review and comment, for the public record, on the environmental impact of proposed Federal actions. Accordingly, a notice of the availability of our comments will be published in the Federal Register.

If you have any questions about our review, please call Mr. James Hooper of my staff, at 312/886-6694.

Sincerely yours,

Barbara Taylor Beckley

Barbara Taylor Beckley, Chief
Environmental Review Branch
Planning and Management Division

Corps Response

1. We agree that this alternative would be preferable from an environmental point of view, but it is both economically infeasible and socially unacceptable.

2. The drainage area covers approximately 16,600 square miles upstream of Chaska and the area removed from the floodplain by the levee includes 390 acres. Therefore, the lost floodwater retention capacity would be insignificant.

3. Noted.

MINNESOTA HISTORICAL SOCIETY

FOUNDED IN 1849

10 June 1982

Colonel William Badger
District Engineer
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

NCSPD-PF
RE: General Design Memorandum and Draft
Supplement for the Minnesota River
at Chaska, Minnesota

<u>MHS Referral File Number</u>: H 280

Thank you for the copy of the above referenced report. We have reviewed those items related to the cultural resources and concur with statement 1. [illegible] on page EIS-6 of the Main Report.

We look forward to assisting your agency with a review of these resources as development plans are realized.

Thank you for your continued close attention to historic and prehistoric values in your planning process.

Sincerely,

for Russell W. Fridley
State Historic Preservation Officer

RWF/fr

Corps Response

1. Noted.

Minnesota Pollution Control Agency

June 23, 1982

Colonel Edward G. Rapp
District Engineer
U.S. Dept. of Army Corps of Engineers
St. Paul District
1135 U.S. Post Office and Customs House
St. Paul, Minnesota 55101

Dear Colonel Rapp:

In response to the Draft Phase I General Design Memorandum and Draft Supplement To The Final Environmental Impact Statement (EIS) for Flood Control and Related Purposes at Chaska, Minnesota dated April, 1982, the Minnesota Pollution Control Agency (MPCA) has two main concerns.

1 First, we are concerned with the water quality impacts of the project. The draft supplement to the final EIS states that there will be an increase in turbidity and sediment load associated with the project, especially during high water events. Methods to control this increase, including planting of vegetation and more long lasting controls should be explored and implemented, if possible, to minimize this impact.

2 Second, we are concerned that an overall integrated approach to flood control be used. In addition to the construction alternatives to control the known flooding potential from existing conditions, the Corps of Engineers should require, as part of the selected alternative, a stormwater management plan developed and adopted by the local units of government and watershed districts to ensure

Phone (612) 296-7301
1935 West County Road B2, Roseville, Minnesota 55113-2785
Regional Offices • Duluth Brainerd Detroit Lakes Marshall Rochester

Colonel [illegible]
Page Two
June [illegible], [illegible]

that existing surface runoff volumes are not increased by changing land uses in the drainage areas of [illegible] and [illegible] Creek. Without a fully integrated management approach that uses both land use controls and construction alternatives to relieve the existing and future flooding potential, problems may occur requiring further costly corrections.

Thank you for the opportunity to comment. If you have any questions, please feel free to contact Deborah [illegible] ([illegible]-72[illegible]) of my staff.

Sincerely,

Louis Breimhurst

Louis J. Breimhurst
Executive Director

Corps Response

1. We have reevaluated high water events following project construction and postproject stabilization. We have concluded that turbidity and sediment loads will not increase during these events. The final supplement will reflect this conclusion.

2. Although we agree that stormwater management plans are a good idea, we cannot require local sponsors to adopt requirements which differ from Federal standards.

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
BOX CENTENNIAL OFFICE BUILDING • ST. PAUL, MINNESOTA • 55155

DNR INFORMATION
(612) 296-6157

FILE NO. ____

[illegible], 1982

Colonel Edward G. Rapp
District Engineer, Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

ATTN: NCSPD-PF

Dear Colonel Rapp:

Thank you for the opportunity to review and provide comments on the Draft Phase I General Design Memorandum and Draft Supplement to the Final Environmental Impact Statement (EIS) for the Minnesota River at Chaska, Minnesota, April, 1982.

As currently described, the Department has some concerns regarding the level of protection recommended within the selected plan (Plan 8). Minnesota rules relating to "Statewide Standards and Criteria for Management of Flood Plain Areas of Minnesota" (Minn. Reg. NR 89(e)) provides in part:

> (2) The minimum height and structural design of any dikes, levees, floodwalls or similar structural works in place, or proposed to be placed in the flood plain shall be based on the flood profile of the regional flood (100-year) confined between the structures subject to the following:
>
> (aa) For urban areas the minimum authorized height and design of proposed structural works shall be at least three feet above the elevation for the regional flood, as confined by the structures, or shall be at the elevation of the standard project flood, whichever provides the greater protection from flooding.

We would note in accordance with the above paragraph (aa) that the level of protection be at the Standard Project Flood (SPF) elevation. The 1982 report indicates that the top of the proposed levee will be at approximately 727.0 which is five feet below the estimated SPF elevation (732.0). This current proposal would not be in compliance with the aforementioned regulation, which, by the way, was supported by the St. Paul District when adopted in 1970.

Colonel Edward G. Rapp
Page Two
July 1, 1982

2 In reviewing this document, Department staff considered for comparsion purposes, the recommended level of protection for the levee adjacent to the Minnesota River within the 1973 Corps of Engineers' document entitled: "Feasibility Report for Flood Control, Minnesota River at Chaska, Minnesota." Significant differences are apparent between the 1973 and 1982 reports with respect to proposed levee height in comparison to the Standard Project Flood (SPF) elevation. The 1973 report indicated the proposed levee would be constructed to the 100-year flood elevation with 4 feet of freeboard. The top of the levee would be 0.5 feet above the SPF elevation of 726.5. The current selected plan (Plan 8) now calls for 100-year flood protection with 3 feet of freeboard. The top of the levee would be 5 feet below the revised higher SPF elevation of 732.0. It is unclear to us why the SPF elevation is significantly higher in the 1982 report. Please provide the rationale for such a significant change.

3 While we recognize the level of protection for the Minnesota River in the current plan is based primarily upon economic considerations, we must address the apparent conflict between the proposed levee height and the aforementioned DNR regulation which would require, in this case, SPF protection. Also, we allude to the Corps of Engineers' draft policy (ER-1105-2-111), November 28, 1979, as mentioned on page 2-2 of the Technical Appendices which sets the SPF as the goal for project construction. We would have preferred that an additional analysis had been conducted which would have determined the feasibility of an increased level of protection between the current plan (100-year plus three foot freeboard) and the SPF elevation. As you know, the current proposed project on the Mississippi River in St. Paul is an example of such an alternative analysis and selection.

4 The Department is quite cognizant of the potential for damages which will remain in the City of Chaska if measures are not taken to provide additional permanent protection. At the same time, we must be assured that an acceptable level of protection is provided prior to allowing the community to relax its flood plain management controls landward of the existing emergency levee. I believe it is appropriate that our respective staffs meet to discuss this issue in greater detail.

In closing, I must state my support for the increased level of protection to be provided for the tributary streams in the current selected plan. This will result in greater protection to the residents of the City and will enhance the water quality in Courthouse Lake which the Department of Natural Resources manages as a trout fishery.

If you have any questions regarding our response, please contact Joel Schilling at 612/296-0438 or myself at 612/296-4810.

Sincerely,

DIVISION OF WATERS

Larry Seymour
Director

cc: Commissioner Joseph Alexander
: Gary Botzek
: Joel Schilling, Policy & Planning
: Kent Lokkesmoe, Regional Hydrologist
: Tim Balcom, Office of Planning

Corps Response

1. We understand that section (2)(cc) of Minnesota Regulation NR 89(e), which deals with modifications to existing structural work, has been used in the past to accommodate potential Corps projects such as the proposed levee project at Houston, Minnesota, where the level of protection would not satisfy your normal requirements. The proposed plan at Chaska would provide protection consistent with State floodplain regulation elevations adopted for the area.

2. The SPF elevation is the result of several hydrologic/hydraulic studies since 1973. As a result of the studies of the lower Minnesota River and pool 2 of the Mississippi River, we have determined that river stages on the Minnesota River at Chaska are often affected by backwater from the Mississippi River. While the discharge for the SPF remains the same as it was in our 1977 report, the water surface profiles produced by this discharge have been revised. The development of the new SPF elevation is discussed on page 4A-12 of appendix 4A and pages 4B-[illegible] and 4B-[illegible] of appendix 4B.

3. The level of protection is based on a number of considerations in addition to economic feasibility. Current Corps guidelines are found in new planning guidance which replaces ER 1105-2-111 and several other regulations. These regulations require that a nonstructural SPF plan be formulated if possible and the [illegible] explained in the report [illegible] SPF protection [illegible] [illegible] as shown on plate [illegible] [illegible] [illegible] developed [illegible]

selecting the SPF plan is contained in appendix 2, pages 2-2, 2-3, 2-23, and 2-24. Briefly, because of a number of constraints on the SPF design, the city and others do not support it.

4. Our regulations deal with evaluation of risk to health, life, and safety. The Minnesota River rises slowly, and flooding can be predicted a number of weeks in advance. The city has demonstrated the ability and determination to fight floods under emergency conditions in the past. In light of these two facts, catastrophic events endangering human life are not likely. If overtopping did occur in spite of emergency action, there would be sufficient time to evacuate residents and some personal property. Community services to those areas located in the floodplain would be interrupted, but would continue to be available to the rest of the community. The city would not be completely paralyzed.

United States Department of the Interior

OFFICE OF THE SECRETARY
NORTH CENTRAL REGION
175 WEST JACKSON BOULEVARD
CHICAGO, ILLINOIS 60604

ER-82/880

July 8, 1982

Colonel Edward G. Rapp
United States Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Rapp:

The Department of Interior (DOI) has reviewed the draft supplement to the final environmental impact statement and draft Phase I General Design Memorandum for the Minnesota River at Chaska, Carver County, Minnesota. Consolidated comments of various DOI branches are provided for your consideration during further project planning activities.

Personnel of the Bureau of Mines have reviewed the general design memorandum and draft supplement to the final environmental impact statement for possible conflict between mineral resources or producing facilities and the proposed project. The documents reevaluate, affirm, and update earlier studies to alleviate flooding on the Minnesota River at Chaska, Minnesota.

This project proposal initially was reviewed by Bureau of Mines' personnel in June 1973, and the feasibility report and revised draft environmental impact statement were reviewed in January 1975. Conclusions of both the 1973 and 1975 reviews were that there would be no adverse impacts on mineral resources as a result of project construction. The current draft supplement and general design memorandum make no significant changes in the previous project proposals. Therefore, they believe the comments made in earlier reviews remain valid and have no objection to either document as written.

The Fish and Wildlife Service has reviewed the above referenced documents and offers the following comments. The documents are well written and accurately depict project-related impacts to fish and wildlife resources and lands within the Minnesota Valley National Wildlife Refuge. The Fish and Wildlife Service supports the Chaska Flood Control Project as proposed, which includes measures to mitigate and compensate for losses to fish and wildlife resources.

Specific comments on the reports deal with the use of Minnesota Valley Refuge lands for construction of the Chaska Creek diversion channel. The City of Chaska is required by the Corps of Engineers to obtain all necessary lands, including easements, agreements, rights-of-way, etc. for construction of the flood control project. At some future time, the City of Chaska will be required to obtain Fish and Wildlife Service approval for the use of the refuge lands. The City will need to make the standard right-of-way request from the Service. Approval for use of refuge lands will likely be in the form of an easement or land exchange. Another possibility may be an agreement with the City or other local units of government whereby the Service will cease its wildlife management responsibilities on those refuge lands used for construction of the Chaska Creek diversion channel in exchange for wildlife management rights on nearby city or county lands.

The Service's St. Paul Field Office has been involved in this project since the early 1970's. In October 1979, a habitat evaluation was initiated for the Chaska Flood Control Project in Chaska. The evaluation was conducted by a tri-agency team of biologists representing the Minnesota Department of Natural Resources, U.S. Corps of Engineers-St. Paul District, and the U.S. Fish and Wildlife Service. The team's analysis was conducted in accordance with the Service's Habitat Evaluation Procedures (HEP).

HEP was applied in two distinct planning stages: (1) in the selection and evaluation of project alternatives, and (2) in the final evaluation of the selected project. With respect to item (1), on March 6, 1981, a planning aid report was submitted to the St. Paul District Corps of Engineers based on preliminary results of the evaluation. The primary objective of the report was to provide decision makers at the District with quantified information concerning project-related impacts to selected habitats for several alternatives under consideration at that time. The product of the report was a general ranking of these alternatives, based on their biological impacts, which was considered by District personnel in selecting final alignments. Final alignments subsequently selected by the District were identified in the report as those having the fewest biological impacts.

On December 23, 1981, a draft Fish and Wildlife Coordination Act (FWCA) report was submitted to the St. Paul District which evaluated the selected plan for flood control in Chaska. The FWCA report quantified project-related impacts to fish and wildlife resources and recommended habitat management measures to minimize and compensate for unavoidable losses to valuable wildlife habitats based on the Fish and Wildlife Service's mitigation policy. The report is included in the Technical Appendices.

With assistance from refuge biologists, the team developed three alternative compensation proposals. Compensation Proposal A involved development of a 19-acre moist soil management unit and construction of a water control structure on Chaska Lake. Compensation Proposal B involved the development of the moist soil unit recommended in Proposal A and a 17-acre shallow impoundment. Proposals A and B are located adjacent to Chaska on the Chaska Lake Unit of the Minnesota Valley National Wildlife Refuge. Compensation Proposal C involved rehabilitation of an existing dike/road and construction of a water control structure and spillway on the Louisville Swamp Unit of the refuge (located approximately three miles south of Chaska). Compensation Proposal A was selected by the Corps of Engineers for inclusion as part of the Chaska Project.

The planning process used for the Chaska Flood Control Project provides an outstanding example of interagency cooperation. Both the St. Paul District Corps of Engineers and Minnesota Department of Natural Resources should be commended for their assistance in conducting the habitat evaluation for the Chaska Project.

Sincerely yours,

Sheila Minor Huff
Regional Environmental Officer

Corps Response

1. All comments noted.

CARVER COUNTY COURTHOUSE
[illegible] EAST 4TH
CHASKA, MINNESOTA 55318

COUNTY OF CARVER

July 12, 1982

Colonel William W. Badger
District Engineer
Department of the Army
St. Paul District [illegible]
1135 U.S. Post Office [illegible]
St. Paul, Minnesota [illegible]

[illegible]

Col. William Badger
July 12, 1982
Page Two

We sincerely appreciate this opportunity for comments and support the continuation of the project.

Sincerely,

Wallace Ess, Vice-Chairman
Carver County Board of Commissioners

WE:gr

Corps Response

1. Noted: We will use the information in phase II.

2. Noted: We will address these concerns in our phase II report.

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT		
NCSPD-PF	Minnesota River at Chaska - Non-Federal Support for Project		
TO MEM FOR RECORD	FROM NCSPD-PF	DATE 20 July 1982	CMT 1
		Mr. Fick/7138	

The City Administrator for the city of Chaska was contacted by telephone on 15 July 1982. He stated that he would discuss the current Administration's proposals for cost sharing with the City Council and Mayor on 19 July 1982. The City Administrator called on 20 July 1982 and stated that the city continues to have strong support for the project. They are aware that the proposed cost sharing policies are beyond the traditional requirements and are voluntary and are subject to adjustment reflecting congressional action.

Edward L. Fick

EDWARD L. FICK
Civil Engineer
Plan Formulation Branch
Planning Division

DA FORM 2496 REPLACES DD FORM 96, WHICH IS OBSOLETE. U.S. GPO 1979-0-310-981 8129

Chaska

August 19, 1982

Department of the Army
St. Paul District
Corps of Engineers
District Engineer
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Sirs:

We are pleased to express our continued support for the Corps project for the Minnesota River at Chaska, including improvement of the East and West Chaska Creeks.

We understand that the project has been approved for construction by Congress with funding consideration to be made at the appropriate time. The City of Chaska is willing to serve as the local sponsor and to cost-share the construction of the project as we have indicated in the past.

[illegible]

[illegible]

[illegible]

HYDROLOGIC INVESTIGATIONS & DESIGN

LIMITED REEVALUATION REPORT

MINNESOTA RIVER AT CHASKA, MINNESOTA

APPENDIX 4

PREPARED BY THE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

APPENDIX 4

HYDROLOGIC INVESTIGATIONS AND DESIGN

APPENDIX 4A

HYDROLOGY

APPENDIX 4A

HYDROLOGY

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

TABLES

PLATES

TABLE OF CONTENTS (Cont.)

PLATES

TABLE OF CONTENTS (Cont.)

PLATES

Number

CLIMATOLOGY

GENERAL

The climate of Chaska and its vicinity is moderate, characterized by wide variations in temperature, normally sufficient rainfall for crops, and moderate snowfall. The Chaska weather observation station of the National Weather Service was established in May 1925 and has been in operation since that time. The station is located 1 mile northeast of Chaska at the American Crystal Sugar plant.

TEMPERATURE

The mean annual temperature for Chaska is about 44°F, with the mean monthly temperature varying from about 72°F in July to 12°F in January. The most extreme temperatures recorded were a high of 109°F on 14 July 1936 and a low of -43°F on 30 January 1951. The average number of days between freezing temperatures is 153, based on a 24-year average.

PRECIPITATION

The normal annual precipitation in Chaska is 26.0 inches. Annual precipitation has ranged from a maximum of 39.94 inches in 1965 to a minimum of 10.44 inches in 1936. The normal monthly precipitation varies from a maximum of 4.00 inches in June to a minimum of 0.73 inch in January. Snowfall records for Minneapolis, Minnesota, which is located approximately 19 miles northeast of Chaska, indicate an average annual snowfall of about 44 inches. The snowfall represents approximately 16 percent of the yearly precipitation.

NOTABLE STORMS

Only one major storm has been recorded for the Chaska vicinity. It centered in Minneapolis. The storm lasted from 24-28 July 1892, during which a maximum depth of 8.4 inches of rainfall occurred in 60 hours. Of this amount, 6.35 inches fell within 12 hours. The maximum rainfall recorded at Chaska for a 24-hour period is 4.96 inches, occurring on 8 July 1955.

STREAMFLOW, RUNOFF AND FLOODS

STREAMFLOW RECORDS

A river gage has been in use on the Minnesota River at Chaska since 31 July 1951. The gage was located on a bridge on State Highway 41 until 13 April 1961 when it was moved about 100 feet downstream to a new bridge on State Aid Road 30. The gage has been at that location since that date. The zero of the gage at both locations has been at elevation 688.0 feet (1929 adj.). The gage is located 29.6 miles above the mouth of the Minnesota River. Daily gage heights were obtained during spring and summer months from August 1951 through 1954. Since that time, daily observations have been made only during periods of high stages and during some spring months. Occasional fragmentary observations have been made at other times.

The U.S. Geological Survey has maintained a stream gaging station on the Minnesota River several miles upstream from Chaska since September 1934. Originally located at river mile 36.0 and called "near Carver," the gaging station was moved upstream to river mile 39.4 on 1 October 1966 and named "near Jordan." The gage zero is 690.0 feet above mean sea level (1929 adj.) at both sites. Drainage areas (approximately 16,200 square

miles and [illegible]. [illegible] River at Chaska. Two [illegible] tributaries [illegible] the Minnesota River between the Jordan gage and Chaska, namely, Sand Creek from the south and Carver Creek from the north. The drainage area of the Minnesota River at Chaska as shown on plate [illegible] of the main report is approximately [illegible] square miles. The largest discharge of record at the Jordan or Carver gaging stations was [illegible],000 cfs (cubic feet per second) on [illegible] April 1965, and the maximum gage height was 34.[illegible]7 feet on 12 April 1965 (affected by backwater from the Mississippi River). The minimum flow of record was [illegible] cfs on 17 November 1955. Average discharge for 46 years is 3,402 cfs.

There are no gage height records on either Chaska Creek or East Creek at Chaska. A few miscellaneous discharge measurements of streamflow have been made by the U.S. Geological Survey on Chaska and East Creeks, both at U.S. Highway 212.

WATERSHED CHARACTERISTICS

On Chaska Creek, U.S. Geological Survey (USGS) topographic maps at a scale of 1:24,000 with 10-foot contour intervals were used to delineate the subwatersheds within the Chaska Creek watershed basin. The Chaska Creek watershed upstream of U.S. Highway 212 was divided into nine subwatersheds. The locations of these are indicated on plate 4A-1 and designated as subwatersheds 1, 1A, 2, 3, 3A, 4, 5, 6, and 7. Watershed boundaries and drainage patterns were field checked at various locations within the Chaska Creek watershed. Information on culvert opening or key channel crossings was obtained from the Milwaukee Road Railroad at various locations or measured in the field.

The headwaters of the West Branch Chaska Creek are located approximately 8 miles northwest of Chaska in subwatershed 5. Gentle slopes are found in this portion of the watershed and range from elevation 950 to

1000. Several small marsh areas are located along the watercourse. The West Branch Chaska Creek joins Chaska Creek approximately 1½ miles northwest of Chaska. The headwaters of the main branch of Chaska Creek, located in subwatershed 7, are approximately 3 miles northwest of the confluence with the West Branch Chaska Creek. Several large marshes exist along the main branch of Chaska Creek. Chaska Creek travels quickly through a steep, deeply ravined area (subwatershed 1) down the bluff to the Minnesota River floodplain, dropping from elevation 950 to elevation 720. Chaska Creek joins the Minnesota River at river mile 29.6. The drainage area of Chaska Creek was determined to be 14.91 square miles upstream of U.S. Highway 212. The subwatersheds range in size from 0.44 to 3.04 square miles.

The develop the unit hydrographs, the HEC-1 computer model required input of Snyder's coefficients which describe watershed response (T_p) and peaking (C_p). Various relationships have been developed between basin characteristics and the Snyder coefficients. Plates 4A-2 and 4A-3 show examples of these relationships, which were first presented in this District's publication, "Feasibility for Flood Control, Bassett Creek Watershed, Hennepin County, Minnesota," March 1976. The Snyder's coefficients required the following subwatershed characteristics to be determined: length of watercourse from the outlet to the upstream limits in the drainage area, length to the center of gravity of the drainage area from the outlet along the watercourse, and the slope associated with the length of the watercourse to the upstream limits of the drainage area.

On East Creek, the drainage area of the watershed was determined to be 11.83 square miles above the confluence with the Minnesota River. The East Creek watershed was divided into 11 subwatersheds using the USGS topographic maps. Field trips to the study area confirmed watershed boundaries. The subwatersheds are shown on plate 4A-1 and designated EC-1 through EC-11. The subwatersheds vary in size from 0.49 to 2.36 square miles.

The features of the East Creek watershed are dominated by the presence of three major lakes. These are Lake Bavaria to the west in subwatershed EC-1, Lake Hazeltine to the east in subwatershed EC-5, and Lake Grace near the center of the East Creek watershed in subwatershed EC-6. Both Lake Bavaria and Hazeltine Lake are formed near the headwaters of the East Creek watershed. The water surface elevation of Lake Bavaria is near elevation 970 and Lake Hazeltine is near elevation 915. East Creek is formed at the outlet of Hazeltine Lake and flows westward approximately 3,000 feet before it enters Lake Grace. The outflow from Lake Bavaria must flow approximately 1 mile east from its outlet through an intermittent flowing channel to Lake Grace. Lake Grace was formed by construction of a dam by the new town "Jonathan" development in 1968. The Lake Grace pool is maintained near elevation 900. East Creek continues flowing to the south and is joined by a western tributary in subwatershed EC-8 near the Minnesota Highway 41 crossing. Downstream of Minnesota Highway 41, the watershed becomes more deeply ravined in subwatershed EC-9. There is a landlocked area shown on plate 4A-1 immediately downstream of Minnesota Highway 41 and south of EAst Creek near EC-8 and EC-9. East Creek leaves the bluffs and enters the Minnesota River floodplain in the vicinity of the Brandondale mobile home development. Downstream of the Brandondale mobile home development, East Creek meanders across the Minnesota River floodplain and into an urban developed area of the city of Chaska. East Creek then enters the Minnesota River at river mile 28.1. Each subwatershed of the East Creek watershed was analyzed to determine the basin characteristics needed to compute the Snyder's coefficients. The physical characteristics of the subwatersheds were computed and the coefficients were determined by the methods previously described.

RUNOFF CHARACTERISTICS

Because of the large difference in drainage areas, the runoff characteristics of the Minnesota River are quite different from those of the creeks. The average discharge for 46 years of 3,402 cfs on the

Minnesota River near Jordan amounts to an average depth of runoff of 2.85 inches per year from the total drainage area. This amounts to 2,465,000 acre-feet per year. Annual runoff at this station has varied from a minimum of 499,000 acre-feet in the water year 1940 to a maximum of 6,985,000 acre-feet in the water year 1969. During most years, streamflow reaches a maximum in late March or April following the spring snowmelt. During some years heavy widespread rainstorms cause additional rises in streamflow, occasionally reaching higher peaks in May or June than the snowmelt runoff peaks. The streamflow generally recedes slowly during the summer months, but with occasional rises following summer storms. The streamflow continues a slow but steady recession during fall months, reaching a minimum discharge usually in February. Monthly flows have varied from a minimum of 6,800 acre-feet in January 1940 to a maximum of 2,869,000 acre-feet in April 1969. Floods rise and fall rather slowly on the Minnesota River and often rise for 2 weeks or more before reaching the peak. The recession is usually slower than the rise with occasional secondary rises before receding to the usual seasonal flows.

Flows in Chaska Creek and East Creek are small during most of the year. There is normally some rise in flow during and immediately after the spring snowmelt, usually in March. Spring rains may prolong the period of high flows. Intense summer rainstorms bring a fast rise in flow, but the high flow may be of short duration, from a few hours to a few days. The lakes and swamps may sustain a continuous flow in the late spring and early summer. By early summer, the infiltration capacity is usually high, so considerable rainfall is required to increase the streamflow.

EFFECT OF LAKE STORAGE

Flows on the Minnesota River are affected by storage in Big Stone Lake, which is the source of the Minnesota River (dam at river mile 329.7); the Minnesota River at U.S. Highway 75 near Odessa, Minnesota (dam at river mile 317.3); and by Lac Qui Parle Lake and Dam (dam at river mile 288.0). These structures have only a slight effect on the flows at Chaska (river mile 29.6). Small dams on tributaries have a negligible effect on the flows of the Minnesota River. Chaska Creek has no dams or lakes but there is a small lake on a tributary. Some marshland is located along the streams in the upper portion of the basin. In the East Creek basin, Lake Bavaria and Hazeltine Lake control runoff from areas of 1.18 square miles and 0.83 square mile, respectively. Storage at Lake Grace Dam, constructed in 1968, may reduce the peak of floods of small volumes in the lower portion of East Creek. Lake Grace Dam has a maximum height of about 25 feet. The location of these lakes is shown on plate 4A-1. Marshland in portions of the basin may reduce the high flows on East Creek.

FLOOD CHARACTERISTICS

Floods on the Minnesota River at Chaska rise and recede rather slowly, because of the large drainage area. The period of rise of large floods varies from about 8 to 20 days while spring floods may recede for several weeks, with occasional minor rises during the general recession. Floods have remained above the point of zero damages as long as 16 days. The four largest floods during the [illegible] years of U.S. Geological Survey records near [illegible] [illegible] peaked in April, following the spring snowmelt. Some of these floods were increased by spring rains. Smaller peaks have occurred during summer or early fall seasons. Almost every year there is a substantial rise in the river stage in March or April, following the spring snowmelt. With the long and slow recession from major floods it is difficult to define the total volume of the floods. The total discharge for a period

of 40 consecutive days, from the beginning of the first substantial rise in flow, amounted to 3.61 inches of runoff on the total drainage area during the 1965 flood and 3.64 inches during the 1969 flood. During most of the floods of record the maximum stage at the Carver gaging station occurred 1 or 2 days after the maximum discharge because of backwater from the Mississippi River. Snow and ice in the river channel at the time of the spring snowmelt may increase stages during the rising period of snowmelt runoff. However, records at the Jordan (or Carver) gaging station indicate that any ice effect at the time of the maximum spring stage or discharge is rare. Ice jams have seldom affected maximum stages of the Minnesota River at Chaska.

Floods on the two creeks are of short duration and may remain at overbank stage for only a few hours. Flood flows may result from rapid snowmelt, accompanied by rainfall, or from very intense rainstorms, usually of short duration, during summer months. The stages of floods in late winter or early spring months may be increased substantially by snow or ice within the channels or by ice jams. Flood stages are not likely to occur during the months of October through mid-February.

FLOODS OF RECORD

Floods on the Minnesota River during the 46 years of record at the Jordan (Carver) U.S. Geological Survey gaging station are listed in the following table. Included are all floods exceeding 37,000 cfs at the stream gaging station. This discharge corresponds approximately to a gage height of 25 feet on the Chaska gage, which is the point of zero damage. However, the stage at Chaska can vary, depending on the amount of backwater from the Mississippi River. All stages on the Carver gage and those since 1966 on the Jordan gage are maximum stages from recording gages, while other stages listed are the highest observed on manual gages.

Table 4A-1 - Floods of record,

Minnesota River in the vicinity of Chaska (1)

Date of flood crest (2)	Gage Height (feet)			Discharge (cfs)	Days above zero-damage elevation (7[illegible] NGVD)(6)
	Chaska (3)	Carver (4)	Jordan (5)		
11 Apr 1965	34.25	34.37	35.16	117,000	15
14 Apr 1969	32.35	32.16	32.85	84,600	16
11 Apr 1951	-	28.00	28.62	64,100	11
16 Apr 1952	29.10	28.31	28.88	60,600	13
26 Jun 1957	25.30	25.82(7)	26.92	40,800	3
4 Apr 1962	24.17	25.12(7)	26.32	39,700	3
24 Oct 1968	24.40	25.20	26.90	37,600	1

(1) Includes floods from September 1934 through September 1981.
(2) Date of peak discharge at Carver or Jordan gaging station. Highest gage heights usually occurred 1 day later than maximum discharge.
(3) Gage on Highway 41 bridge at river mile 29.6. Zero is 688.0 feet, mean sea level (1929 adj.).
(4) Former U.S. Geological Survey gage at river mile 36.0. Zero is 690 feet, mean sea level (1929 adj.).
(5) Present U.S. Geological Survey gage at river mile 39.4. Zero is 690 feet, mean sea level (1929 adj.).
(6) Corresponds approximately to point of zero damages at Chaska, depending on backwater effect.
(7) Stage affected by backwater from Mississippi River. Maximum stage occurred 1 or 2 days later than maximum discharge.

NOTE: Point of zero damage at Chaska is approximately 25 feet on Chaska gage.

The largest flood known on the Minnesota River at Chaska was that of April 1965. The previous winter, from mid-November, was generally colder than normal and frost penetration was deep. Snowfall was about normal through January but was well above normal in February. Thawing temperatures and rain early in March melted some snow but colder temperatures later formed a layer of ice that subsequently increased the runoff.

Heavy snowfall covered the basin on 17 and 18 March, with 14 inches of new snowfall at New Ulm. Additional snowfall occurred later in March. Temperatures were well below normal in most of March. At the end of March the water equivalent of the snow cover was about 6 inches on the lower part of the Minnesota River basin. Thawing weather started about the first of April with temperatures becoming progressively warmer. From 1 to 2 inches of rainfall occurred on 3 to 6 April, adding to the snowmelt runoff. Streamflow of the Minnesota River at the Carver gaging station increased starting about 1 April and reached a peak discharge of 117,000 cfs on 11 April. The maximum stage at the Carver gaging station was 34.37 feet on 12 April (with backwater from the Mississippi River). The highest daily reading on the Chaska gage was 34.25 feet on 13 April.

The flood of April 1969 was the second largest in the period of record on the Minnesota River in the vicinity of Chaska. The flood was preceded by a wet fall, with more than twice the normal precipitation in September and October. This rainfall resulted in a record fall flood from Mankato, Minnesota, to the mouth of the Minnesota River in the latter part of October. Frequent and heavy snowfalls in December and January caused an unusually high depth of snow on the basin. Snowfall during February and March was below normal but temperatures remained cold until mid-March. Streamflow remained at more than twice the normal throughout the winter. Warmer temperatures caused some snowmelt after the middle of March, until a cold spell prevented melting the latter part of March. There was little precipitation during this period or in April. [illegible] temperatures early in April melted all remaining snow. After [illegible] few days in April the streamflow increased rapidly [illegible] the Jordan gaging station the maximum discharge [illegible] and the maximum gage height was 32.85 feet [illegible] the maximum stage observed was 32.[illegible] feet [illegible] New Ulm, this flood was higher [illegible] River.

AD-A184 474 MINNESOTA RIVER AT CHASKA MINNESOTA TECHNICAL APENDIXES LIMITED REEVALUA..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT AUG 82 3/9

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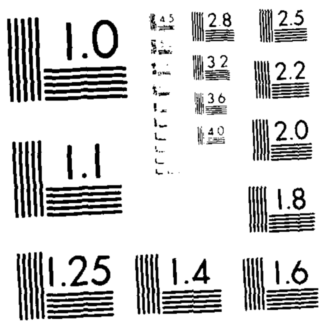

1.0
4.5
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

Smaller floods occurred on the Minnesota River at Chaska in April 1951, April 1952, June 1957, April 1962, and October 1968. These are listed in the previous table. Of the seven floods listed in the table, five were caused by snowmelt, with or without additional rainfall, and only two were caused by rainfall alone. At Mankato, 77 river miles upstream from Chaska, a flood occurred in 1881, which was reported to have been 0.8 foot higher than the 1965 flood and was the highest known there. Major floods occurred at Mankato in 1903, 1908, and 1919, and smaller floods occurred in other years, before gage records started near Carver or at Chaska. Undoubtedly, there were floods also in Chaska during these same years.

The largest flood at Chaska from overflow of the creeks for which detailed information is available occurred in the late evening of 20 July 1951. The flood-producing storm covered portions of southern and central Minnesota with widely varying amounts of rainfall. In the vicinity of Chaska the rainfall occurred approximately from 8 p.m. on 20 July until 2 a.m. 21 July. Rainfall at the Weather Bureau gage, 1 mile northeast of Chaska, totaled 3.95 inches. It was reported that a downpour of rain lasted 1 hour and 45 minutes and that the total amount of rainfall at Chaska was $4\frac{1}{2}$ inches. Within $1\frac{1}{2}$ hours, the creeks spread over two sections of the city. Although not as extensive and devastating as the overflow from the Minnesota River in April 1951, it inflicted a sudden scare to residents in each of the creek sections. The floodwaters vanished almost as quickly after the rain ended as the inundation took place during the torrential downpour.

No information is available on other floods on Chaska or East Creeks. Local residents have reported that other floods have occurred on both creeks and have caused damage, but no dates or details are available.

FLOOD FREQUENCY CURVES

MINNESOTA RIVER

River stages at Chaska on the Minnesota River are often affected by backwater from the Mississippi River. There is no single rating curve at Chaska, so an elevation-frequency curve was derived rather than a discharge-frequency curve and a rating curve. The elevation-frequency curve for Chaska used in the present studies is one of a series of elevation-frequency curves developed at various communities on the lower Minnesota River. The curve at Chaska was derived as a result of HEC-2 backwater computations completed by the U.S. Geological Survey and verified by this District. Mississippi River flood stages were considered in the determination of the elevation-frequency curve at Chaska. Model calibrations on the 1969 flood were used to reflect current basin conditions. The results of the U.S. Geological Survey and Corps studies have been administratively coordinated, and form a basis for floodplain regulation in the basin.

CHASKA CREEK AND EAST CREEK EXISTING CONDITIONS

There are no discharge records on Chaska Creek or on East Creek. The method used in this analysis was developed by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, using the HEC-1 Flood Hydrograph Package computer program. This method requires determining coefficients based on basin characteristics such as topography, soil conditions, pervious and impervious areas, vegetal cover, basin shape, slope, and size. Based upon these basin characteristics, a unit hydrograph is developed by the computer model. Losses may be estimated by several options, and theoretical or observed rain patterns can be used. The model then determines the amount and timing of the resultant runoff. Discharges can be determined for various subwatersheds, combined and hydraulically routed downstream.

For both the Chaska Creek and East Creek models, the HEC-1 rainfall excess option chosen was the Soil Conservation Service (SCS) method of determining rainfall excess. The SCS method uses the curve number (CN) technique to relate total precipitation directly to total rainfall excess with a series of curves. The curve number (CN) is determined by estimating a number of subwatershed characteristics, including percentage of various soils types, percentage of impervious area, land usage, and other factors. The U.S. Department of Agriculture's publication, "Soil Survey Carver County", November 1968, was used to determine the percent of each of the four major soil types in each of the subwatersheds in both East and Chaska Creek. Land use maps and topographic maps were supplemented by field surveys to estimate the land usage in each of the subwatersheds. Based on the computations, a curve number was determined for each of the subwatersheds which represents the rainfall excess potential of each area.

The antecedent moisture condition (AMC) for the Chaska Creek and East Creek hydrologic study was estimated to be equivalent to the SCS's AMC-III condition. The SCS method has three antecedent moisture condition ranges--low (I), normal (II), and severe (III). The severe antecedent moisture condition option (AMC-III) was selected to represent the soil moisture conditions that would be expected to produce runoff characteristics of the 1-percent chance flood. The antecedent moisture condition is represented in the computer model by the wetness coefficient. The value of this coefficient changes as the function of the curve number. The Soil Conservation Service's National Engineering Handbook (NEH), Section 4, Hydrology, Table 10.1 was used to determine the wetness coefficient.

CHASKA CREEK AND EAST CREEK FUTURE CONDITIONS

Flood frequency relationships were developed for the East Creek and Chaska Creek watersheds under future conditions. The year 2030 was determined to be the target year to estimate the flood frequency relationships for future conditions. A land use plan for the year 2030 for the East Creek watershed was used in this analysis (see Appendix 10, Economic Analysis). The degree of urbanization in each subwatershed was then

estimated in East and Chaska Creeks. The watershed characteristics were recomputed on the basis of the future expected condition, and the Snyder's coefficients were appropriately modified to reflect the increase in urbanization. The increased urbanization also affected the runoff characteristics of each of the subwatersheds. The changes in the land usage were appropriately reanalyzed in each of the subwatersheds and the curve numbers (CN) adjusted accordingly.

The following table presents a summary of watershed characteristics considered in the determination of synthetic hydrograph coefficients. These included the drainage area, watercourse length, length from the outlet of the subwatershed to its centroid, a representative slope, and the percentage of the subwatershed that is represented by water surfaces such as lakes and marshes. The changes in Snyder's T_p and C_p are intended to reflect the anticipated change in the unit hydrograph due to the effects of urbanization in that particular subwatershed.

There are no small watersheds in the Chaska vicinity with similar storage characteristics that are currently being gaged with which to compare or correlate the results of this study.

Table 4A-2 - Summary of watershed characteristics and synthetic hydrograph values

Watershed designation	Watershed characteristics: Watershed area (square miles)	Length of drainage path (miles)	Length to centroid (miles)	Representative slope (percent)	Water surface area (percent)	Existing conditions: Snyder's T_p (hours)	Snyder's C_p (hours)	30-minute unit hydrograph peak (cfs)	Curve number (CN)	Wetness coefficient	Adjusted curve number (CN)	Future conditions: Snyder's T_p (hours)	Snyder's C_p (hours)	30-minute unit hydrograph peak (cfs)	Curve number (CN)	Wetness coefficient	Adjusted curve number (CN)
East Creek																	
EC1	1.30	0.95	0.49	1.28	14	0.80	0.58	540	79	1.15	90.9	0.40	0.50	995	80	1.14	91.2
EC2	2.36	2.46	0.91	1.02	2	1.56	0.68	625	76	1.17	88.9	0.55	0.53	1360	80	1.14	91.2
EC3	0.63	1.67	0.70	1.02	0	1.22	0.64	210	73	1.19	86.9	0.35	0.49	490	78	1.15	89.7
EC4	0.59	1.25	0.70	1.06	0	0.60	0.54	330	80	1.14	91.2	0.30	0.47	525	86	1.10	94.6
EC5	0.91	0.61	0.22	2.19	23	0.41	0.50	700	82	1.13	92.7	0.25	0.41	729	86	1.10	94.6
EC6	0.70	0.74	0.21	2.18	37	0.30	0.47	650	75	1.17	87.8	0.15	0.41	779	79	1.15	90.9
EC7	1.82	3.44	1.89	0.73	0	2.20	0.72	390	72	1.20	86.4	0.70	0.56	799	77	1.16	89.3
EC8	0.54	1.44	0.64	1.67	0	0.60	0.55	302	73	1.19	86.9	0.25	0.41	455	76	1.17	88.9
EC9	1.35	2.02	1.11	2.10	0	0.27	0.46	1336	73	1.19	86.9	0.22	0.44	1405	77	1.16	89.3
EC10	1.14	1.55	1.09	1.96	10	0.65	0.61	626	75	1.18	88.5*						
EC11	0.49	1.27	0.49	0.45	6	0.22	0.44	480	78	1.15	89.7*						
Chaska Creek																	
1	1.43	2.04	1.10	1.29	1	0.35	0.49	1325	77	1.16	89.3	0.18	0.45	1765	80	1.14	91.2
1A	0.44	1.25	0.57	0.99	0	1.00	0.58	150	82	1.13	92.3	0.19	0.43	490	83	1.12	93.1
2	0.97	1.44	0.87	0.57	4	1.45	0.65	269	77	1.16	89.3	0.26	0.45	950	82	1.13	92.6
3	2.53	2.92	1.40	0.21	9	2.70	0.73	436	82	1.13	92.3	1.16	0.60	793	84	1.11	93.2
3A	0.65	1.10	0.49	0.05	7	1.50	0.61	165	74	1.19	87.7	0.67	0.64	400	79	1.145	90.5
4	3.04	2.50	1.17	0.21	5	2.50	0.74	580	76	1.17	88.9	2.50	0.74	580	84	1.11	93.2
5	2.76	2.16	1.06	0.26	10	2.10	0.69	580	80	1.14	91.2	2.10	0.69	580	84	1.11	93.2
6	1.60	1.25	0.72	0.50	12	1.30	0.63	483	70	1.21	84.7	0.24	0.45	1706	80	1.14	91.2
7	1.50	2.23	1.14	0.74	13	1.80	0.68	357	80	1.14	91.2	0.78	0.55	670	81	1.13	91.5

*East Creek future conditions are presented in Appendix 4C, Interior Drainage, table 4C-2.

PRECIPITATION

For Chaska Creek and East Creek, a 24-hour duration storm was analyzed. The 30- and 60-minute rainfall data were obtained from the National Oceanographic and Atmospheric Administration's (NOAA) Technical Memorandum NWS HYDRO-35, "5- and 60-Minute Precipitation Frequency for the Eastern and Central United States." The remaining rainfall data were obtained from the Weather Bureau's Technical Paper No. 40 "Rainfall Frequency Atlas of the United States." The drainage area-rainfall reduction factors were obtained from Figure 15 of Technical Paper No. 40. Identical precipitation values were used for the existing and future conditions.

Technical Paper No. 40 (T.P. 40) does not give incremental rainfall in half-hour intervals. These values were obtained by plotting the mass precipitation versus time and interpolating the required incremental value. The rainfall values were adjusted to annual frequency according to factors in table 2 of T.P. 40.

FLOOD ROUTING MODEL

An HEC-1 computer model was developed to perform flood routings. Initially, after the Snyder's unit hydrograph coefficients were determined, the 5-minute unit hydrographs were developed for each of the subwatersheds. A time interval of 30 minutes was used as the computation time interval. This time interval was selected because the hydrograph peaks are delayed considerably due to hydraulic routing through the reservoirs in the watersheds and because of the constraint of a limited number of computation time increments allowed by the computer model. The 30-minute unit hydrographs were developed from the 5-minute unit hydrographs using S-curve techniques. These hydrographs were adjusted slightly to provide a peak discharge, similar to those obtained using the 5-minute unit hydrographs.

The runoff was computed using the information compiled from each subwatershed. The amount of rainfall analyzed in each watershed was adjusted on the basis of the total tributary drainage area using the drainage area-rainfall relationship. In watersheds where reservoir routing was required, stage-discharge relationships were developed for the various outlet structures. Storage behind the structures was estimated from topographic maps. These relationships were adjusted to reflect existing conditions. Culverts and waterway openings were obtained from field measurements. Channel routing was computed by estimating the time lag from each subwatershed to the next subwatershed and storage-discharge relationships were developed using length of the watercourse, typical cross sections, and Manning's equation. No alterations to the existing reservoirs or channels were assumed for future development of the subwatershed.

The storage-elevation and outflow rating curves were developed for the existing Lake Grace dam and reservoir. The outflow rating curve was developed on the basis of field observations because no outflow rating curve was available.

The outlet rating curve for subwatershed EC-2 was simplified. The tailwater below the outlet of EC-2 was assumed to be at the same elevation as the Lake Grace pool. This assumed that a significant head loss across the 20-foot diameter pipe immediately upstream of the Lake Grace dam does not occur.

The peak discharges for existing and future conditions for various frequency storms at the outlets of the subwatersheds of Chaska and East Creeks are presented in the following tables. The discharge-frequency curves for Chaska Creek and East Creek for existing and future conditions are presented on plates 4A-7 and 4A-8, respectively.

Table 4A-3 - Chaska Creek peak discharges

Sub-watershed number(1)	2-yr. storm	5-yr. storm	10-yr. storm	25-yr. storm	50-yr. storm	100-yr. storm	500-yr. storm
Existing conditions							
7	135	360	480	670	840	1010	1220
6	175	350	465	585	740	900	1100
5	55	85	100	120	140	155	160
4	60	95	155	230	310	390	485
3A	55	90	120	160	210	260	310
3	340	570	700	835	1020	1190	1440
2	360	600	750	900	1100	1280	2750
1A	250	370	490	620	780	950	1180
1	1200	1720	2080	2540	2900	3300	4150
Future conditions							
7	195	475	670	935	1220	1430	1780
6	250	440	575	725	910	1080	1330
5	60	90	110	130	150	155	165
4	75	140	210	290	375	450	530
3A	65	105	150	190	240	285	340
3	430	710	870	1090	1320	1530	1810
2	1000	1380	1640	1950	2230	2530	2850
1A	500	675	830	970	1125	1290	1440
1	1780	2510	3040	3700	4200	4700	5900

(1) See plate 4A-1 for subwatershed locations.

Table 4A-4 - East Creek peak discharges

Sub-watershed number[1]	2-yr. storm	5-yr. storm	10-yr. storm	25-yr. storm	50-yr. storm	100-yr. storm	500-yr. storm
Existing conditions							
1	10	15	20	25	30	35	40
2	360	530	630	720	825	910	1060
3	225	330	400	475	550	625	765
4	2	3	4	4	5	6	26
5	4	6	7	9	10	11	13
6	260	410	525	630	750	870	1150
7	450	655	790	935	1080	1240	1520
8	565	725	840	930	1040	1140	1400
9	1110	1650	2050	2550	2930	3350	4300
10	1100	1640	2040	2530	2920	3380	4350
11	1110	1650	2040	2520	2910	3330	4320
Future conditions[2]							
1	10	15	20	25	30	35	40
2	485	675	785	885	985	1080	1210
3	490	685	815	980	1130	1270	1470
4	3	4	4	5	5	8	38
5	5	7	8	9	10	12	14
6	315	500	625	740	895	1050	1270
7	880	1260	1500	1800	2080	2360	2720
8	710	895	975	1060	1140	1220	1440
9	1320	1940	2380	2930	3380	3820	4800

(1) See plate 4A-1 for subwatershed locations.

(2) East Creek future conditions for subwatersheds 10 and 11 are presented in table 4C-9.

The flood hydrographs at Highway 212 for existing and future conditions on Chaska Creek are shown on plates 4A-9 to 4A-18.

Flood hydrographs for East Creek for existing and future development are presented on plates 4A-21 to 4A-30. The East Creek flood hydrographs are presented for two locations: (1) East Creek upstream of Lake Grace and (2) the location of the proposed diversion structure.

Flood frequency relationships were also developed for the East Creek watershed under project conditions. Highway 41, which crosses East Creek at the outlet of EC-8, will have the present culvert replaced by a bridge. Because of the amount of fill that will be removed with the culvert, it was assumed that the bridge opening could pass the standard project flood. Additional computer runs were made to determine the effect at the proposed diversion location. The future condition watershed characteristics were assumed, with the reservoir storage effect of the Highway 41 embankment removed from the model. It was found that flow from the area above Lake Grace effectively is stored and contributes flow on the flood recession at the diversion, and that the combined hydrographs of EC-7 and EC-8 are routed to the proposed diversion location prior to the contribution of flow from the EC-9 subwatershed.

STANDARD PROJECT FLOODS

MINNESOTA RIVER AT CHASKA

A standard project flood has previously been derived for the Minnesota River near Carver. This standard project flood has a peak of 168,000 cfs. The derivation is given in "Report on Probable Maximum Floods and Standard Project Floods for Minnesota River Basin, Minnesota," by the St. Paul District Office, dated January 1971. This peak value was based on an

adopted standard project flood at Mankato of 155,000 cfs and drainage area relationships of peak flows for floods of record. The drainage area at the Mankato gage, 14,900 square miles, is 8 percent less than that at the Carver gage. The Mankato standard project flood was determined in a lengthy investigation of the Minnesota River basin, which involved dividing the basin into seven subareas and using routing and combining procedures. Floods were computed for the all-season (summer) storm and various combinations of spring snowmelt and rainfall runoff. The adopted standard project flood at Mankato, 155,000 cfs, is from a combination of rainfall immediately following the snowmelt runoff.

The drainage area of the Minnesota River at Chaska, shown on plate 1 of the main report, is approximately 16,600 square miles while that at the Carver gaging station is 16,200 square miles. The standard project flood drainage area line from Mankato to Carver, on plate 27 of the above mentioned report, was extended to 16,600 square miles. This line represents approximately the 0.7 power of the drainage area ratio. The standard project flood for the Minnesota River at Chaska is then determined to be 168,000 cfs.

CHASKA CREEK AND EAST CREEK

The standard project flood was determined for the East Creek and Chaska Creek watersheds. The HEC-1 model described in the previous sections of this report was used for this analysis. Unit hydrographs and runoff coefficients previously developed for existing and future conditions were also used for the development of the standard project flood. The standard project storm was computed in accordance with EM-1110-2-1411, "Standard Project Storm Determinations." The standard project storm index rainfall for the Chaska, Minnesota, area was determined to be 10 inches. The standard project storm option of the HEC-1 computer model was used to obtain the 96-hour storm pattern in hourly

increments. The precipitation was then reduced by the "Hop Brook" factor as described in EC-1110-2-163 (Draft Engineering Manual), "Spillway and Freeboard Requirements for Dams." This reduction was 19.5 percent for East Creek and 18.7 percent for Chaska Creek. The half hour incremental precipitation was developed by plotting the mass precipitation versus time and interpolating the half hour increments.

Because of the constraints of the computer model, only the most severe 72 of the 96-hour storm were modeled. In the East Creek basin, 0.27 inch of precipitation fell within the first 24 hours of the 96-hour standard project storm and was not modeled. This precipitation can be expected to contribute to initial losses and not contribute to the peak. During the same time period, 0.28 inch fell in the Chaska Creek watershed. In the remaining 72 hours, 11.67 inches fell in the East Creek watershed and 11.53 inches in the Chaska Creek watershed. The drainage area-rainfall depth relationships used were computed from the EM-1110-2-1411.

The peak discharges from each of the subwatersheds in Chaska Creek and East Creek for existing and future conditions are presented in the following table. The flood hydrographs for the standard project flood at the mouth of the West Branch Chaska Creek and Chaska Creek at U.S. Highway 212 are shown on plate 4A-19 for existing conditions and plate 4A-20 for future conditions. Plates 4A-31 and 4A-32 present the standard project flood hydrographs at various locations in East Creek under existing and future conditions. The locations of the hydrographs presented are upstream of Lake Grace and East Creek at the diversion.

Table 4A-5 - Standard project storm peak discharge

Chaska Creek			East Creek		
Sub-Watershed	Existing Condition	Future Condition	Sub-Watershed	Existing Condition	Future Condition
7	1,580	2,000	1	80	80
6	2,140	2,420	2	1,470	1,580
5	200	205	3	865	1,230
4	670	680	4	365	390
3A	505	520	5	40	41
3	2,200	2,570	6	1,750	2,340
2	2,500	2,920	7	1,940	2,800
1A	2,260	2,800	8	2,740	3,300
1	4,700	5,550	9	3,780	4,080
			10	3,800	(1)
			11	3,850	(1)

(1) Future conditions for East Creek subwatersheds 10 and 11 are presented in table 4C-9.

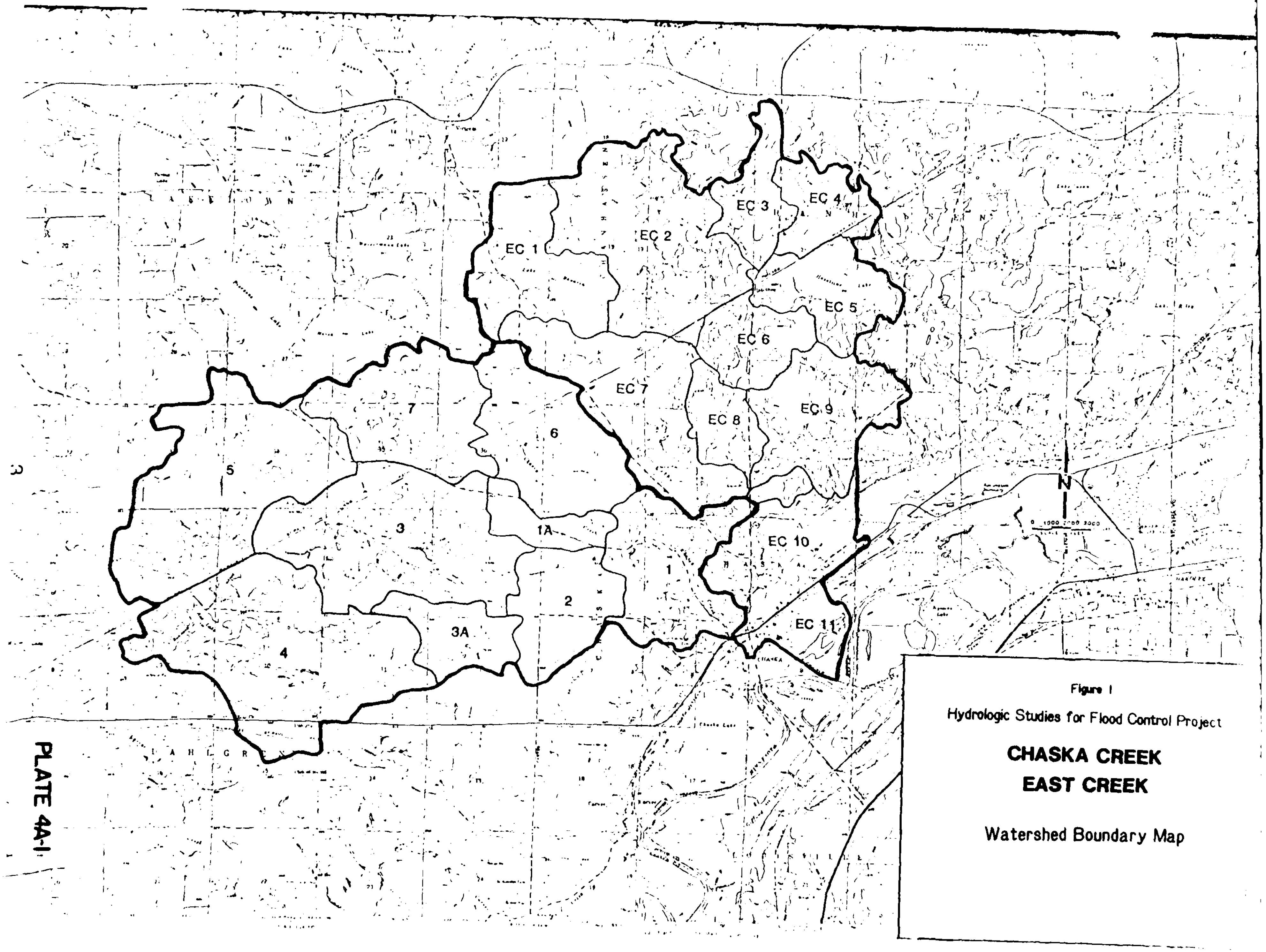


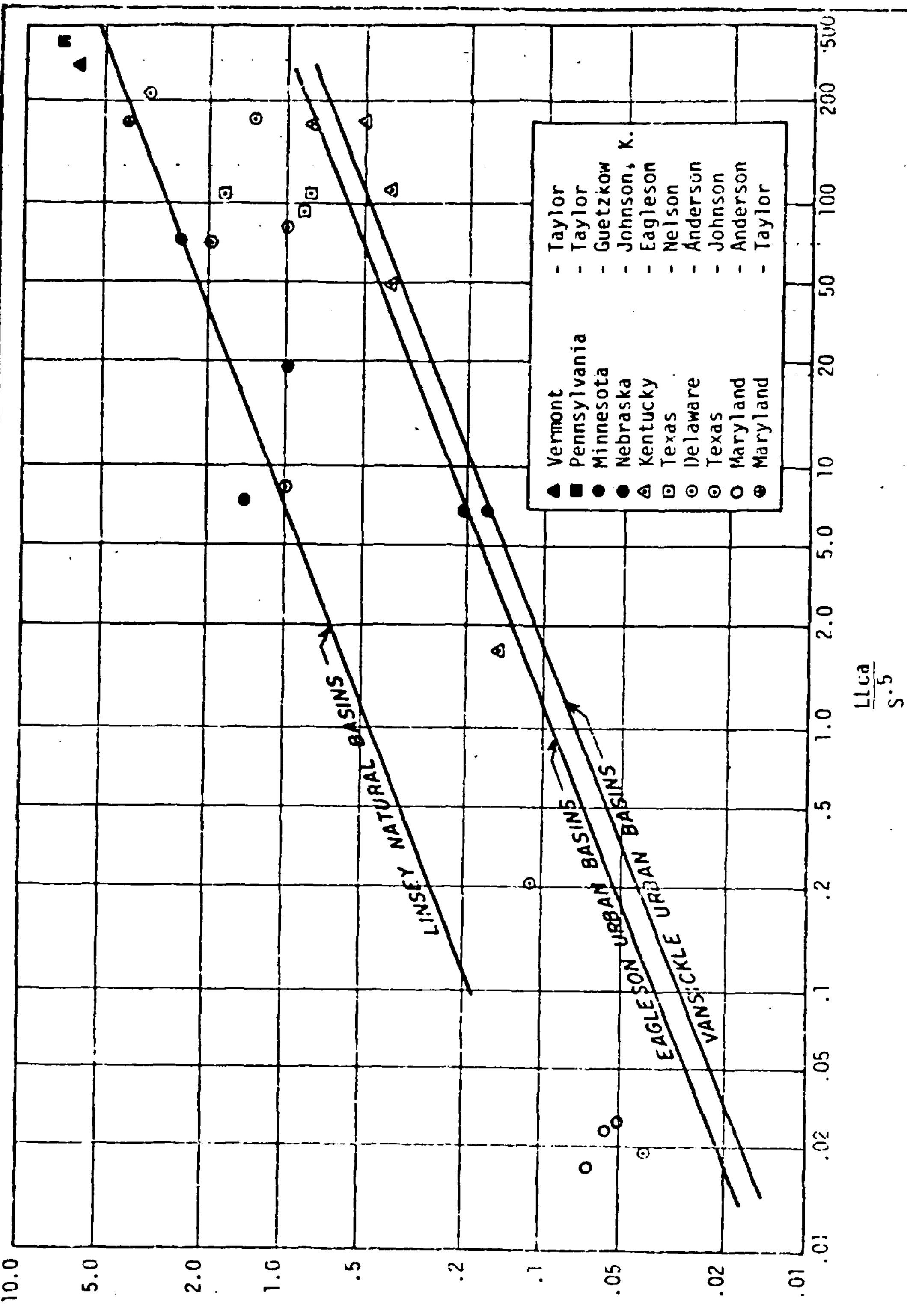
Figure 1

Hydrologic Studies for Flood Control Project

CHASKA CREEK
EAST CREEK

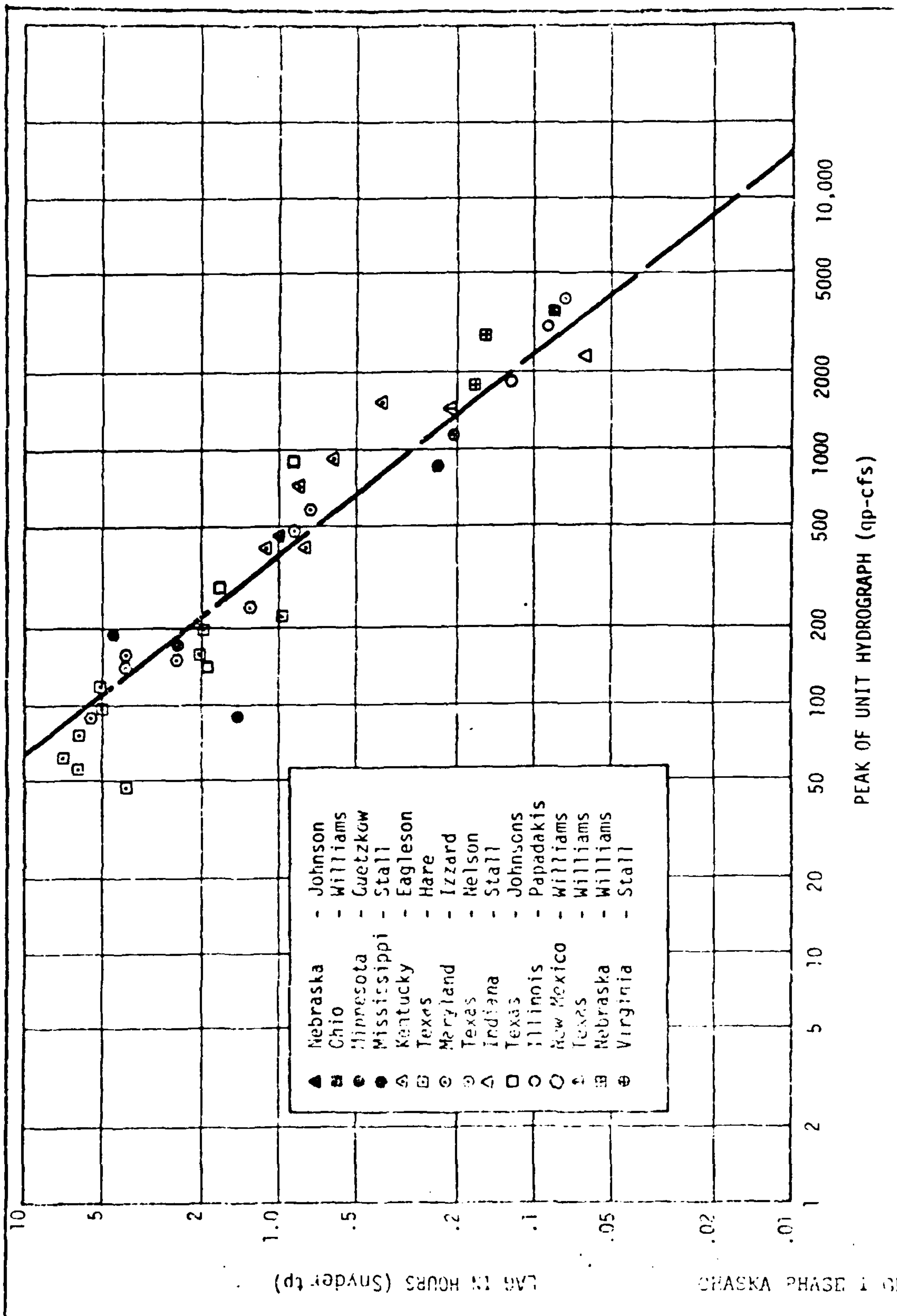
Watershed Boundary Map

PLATE 4A-1



CHASKA PHASE 1 GDM

BASIN LAG VERSUS
BASIN CHARACTERISTICS



CHASKA PHASE I GDM

BASIN LAG VERSUS
UNIT HYDROGRAPH PEAK

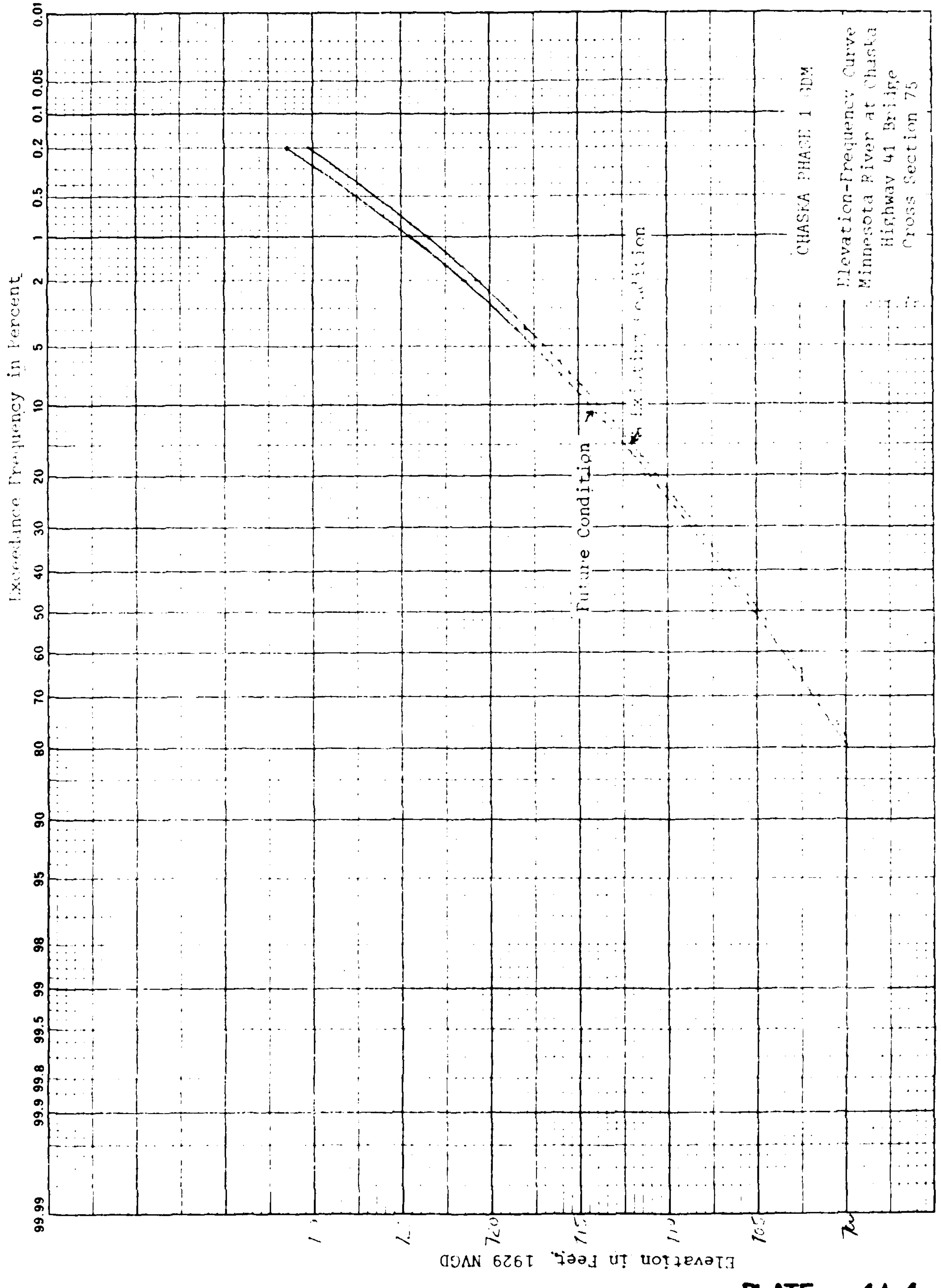

CHASKA PHASE 1 GDM
Elevation-Frequency Curve
Minnesota River at Chaska
Highway 41 Bridge
Cross Section 75
Exceedance Frequency in Percent
Elevation in Feet, 1929 NVGD
Future Condition
Existing Condition
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.99

PLATE 4A-4

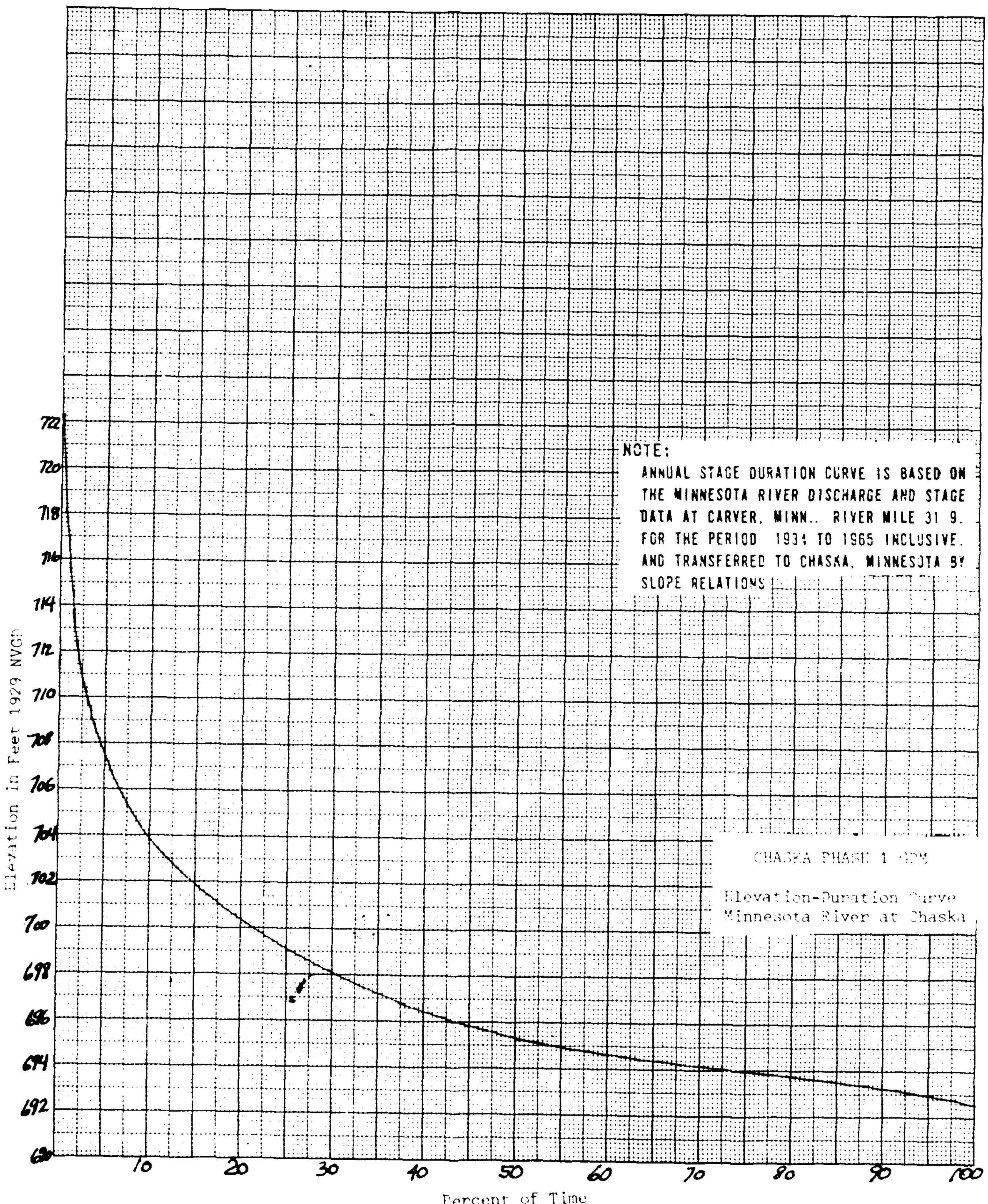

NOTE:
ANNUAL STAGE DURATION CURVE IS BASED ON THE MINNESOTA RIVER DISCHARGE AND STAGE DATA AT CARVER, MINN., RIVER MILE 31.9, FOR THE PERIOD 1934 TO 1965 INCLUSIVE, AND TRANSFERRED TO CHASKA, MINNESOTA BY SLOPE RELATIONS.
CHASKA PHASE 1 GDM
Elevation-Duration Curve
Minnesota River at Chaska
Elevation in Feet 1929 NVGD
722
720
718
716
714
712
710
708
706
704
702
700
698
696
694
692
690
10
20
30
40
50
60
70
80
90
100
Percent of Time

PLATE 4A-5

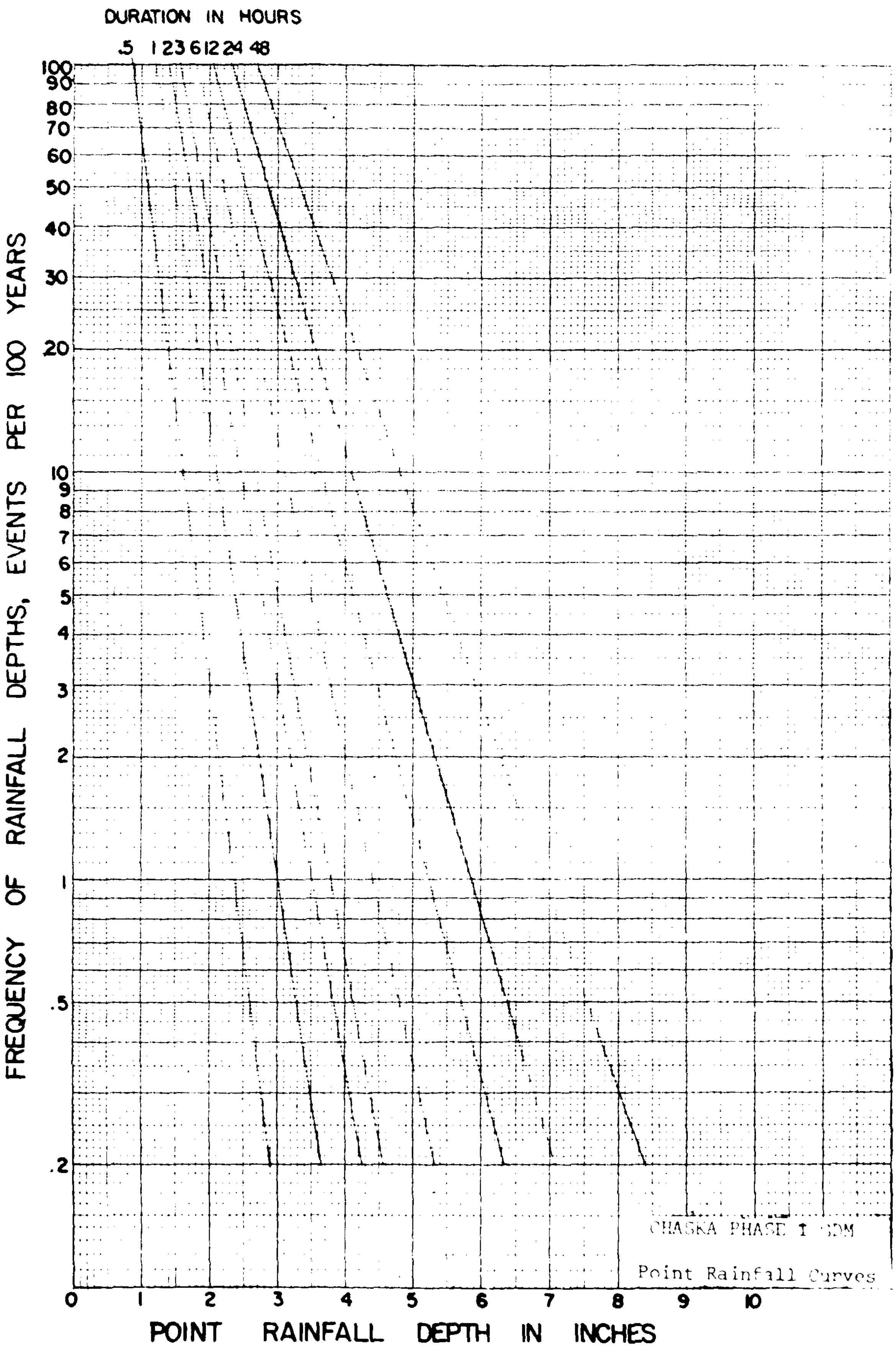
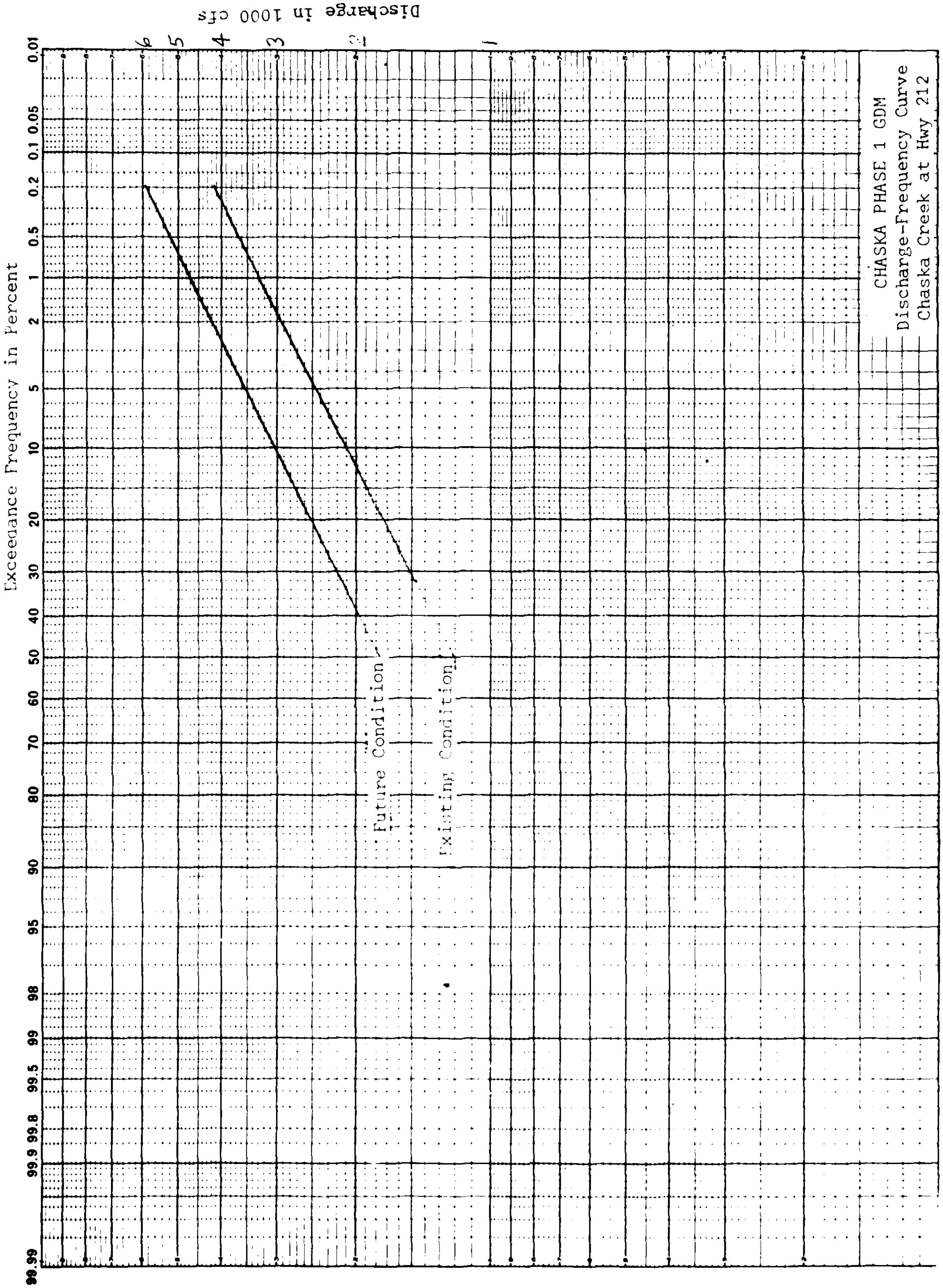
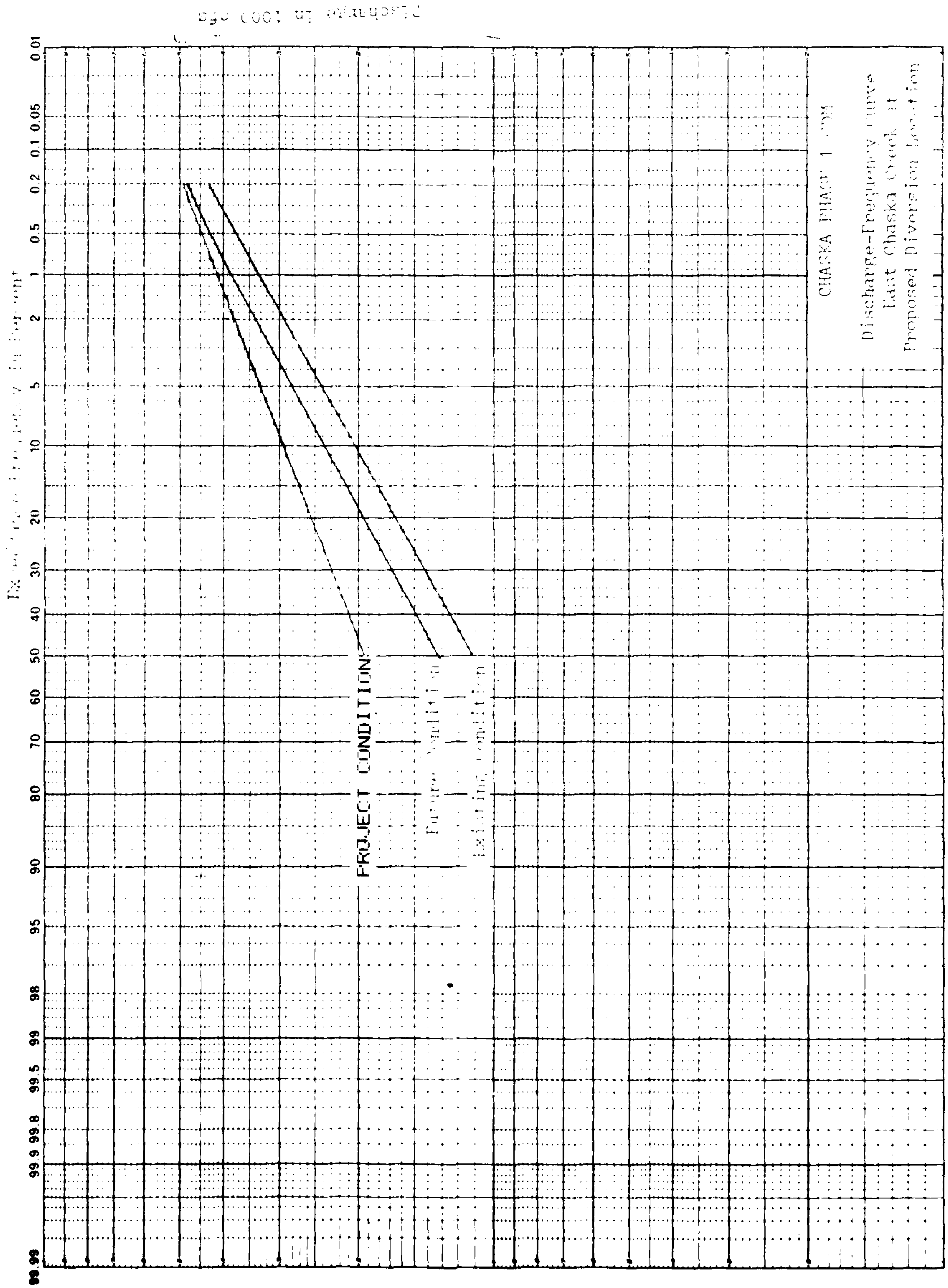

DURATION IN HOURS
.5 1 2 3 6 12 24 48
FREQUENCY OF RAINFALL DEPTHS, EVENTS PER 100 YEARS
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
.5
.2
0 1 2 3 4 5 6 7 8 9 10
POINT RAINFALL DEPTH IN INCHES
CHASKA PHASE I GDM
Point Rainfall Curves

PLATE 4A-6


CHASKA PHASE 1 GDM
Discharge-Frequency Curve
Chaska Creek at Hwy 212
Discharge in 1000 cfs
Exceedance Frequency in Percent
Future Condition
Existing Condition
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.99
6
5
4
3
2
1



CHASKA PHASE 1
Discharge-Frequency Curve
East Chaska Creek at
Proposed Diversion Location
PROJECT CONDITION
Existing Condition
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9

PLATE 4A-8

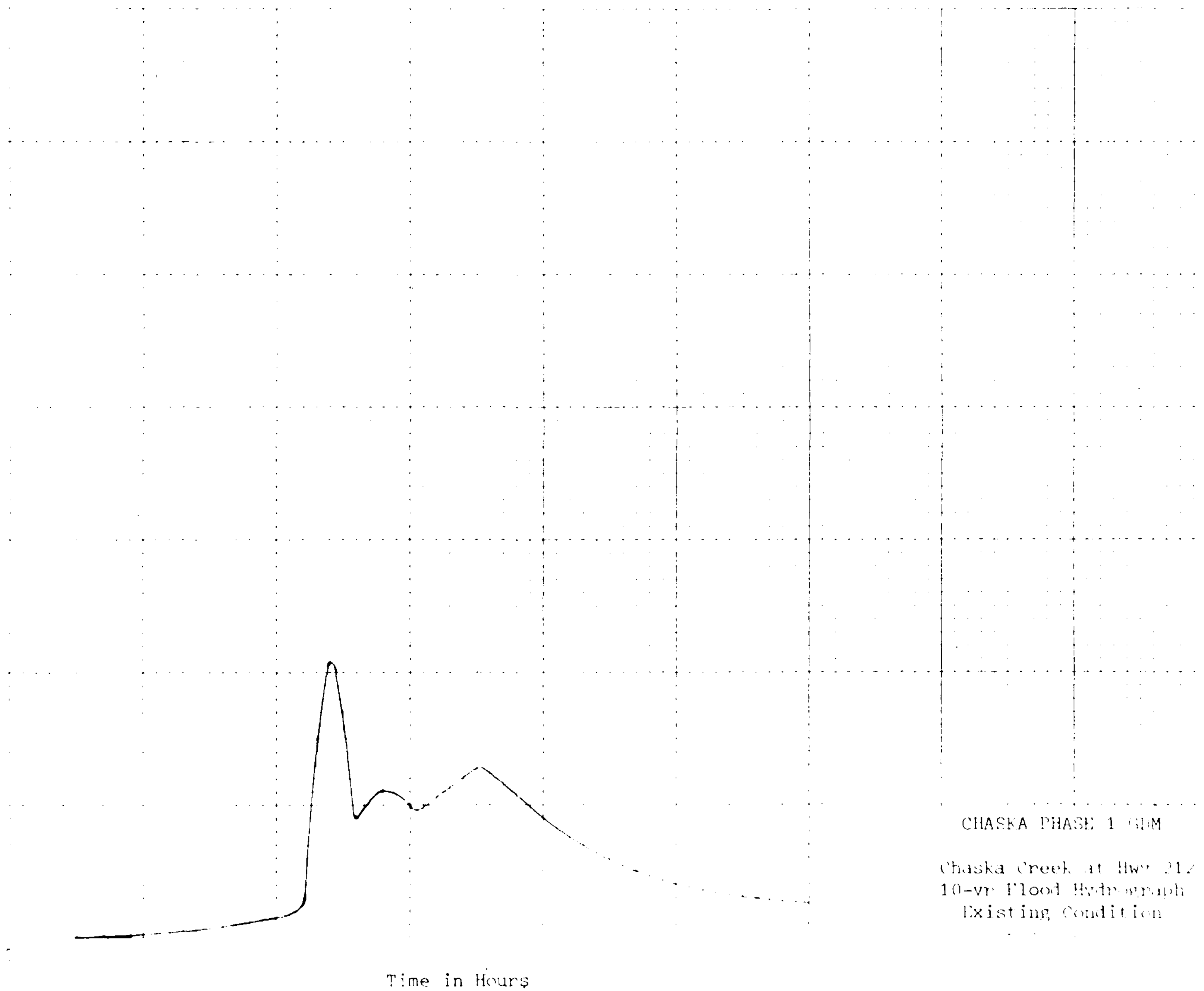
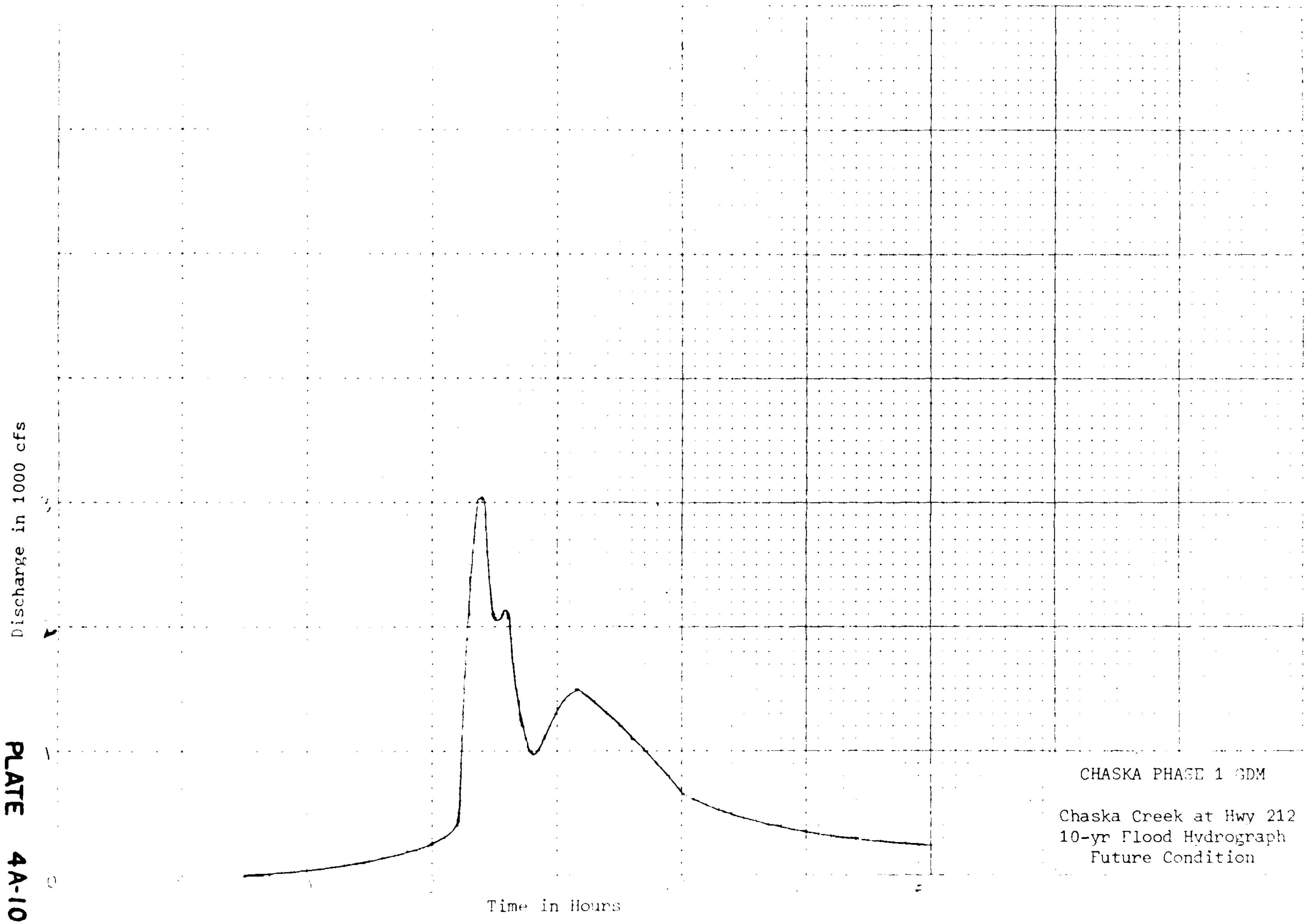

CHASKA PHASE 1 GDM
Chaska Creek at Hwy 212
10-yr Flood Hydrograph
Existing Condition
Time in Hours

PLATE 4A-9



Discharge in 1000 cfs
Time in Hours
CHASKA PHASE 1 GDM
Chaska Creek at Hwy 212
10-yr Flood Hydrograph
Future Condition

PLATE 4A-10

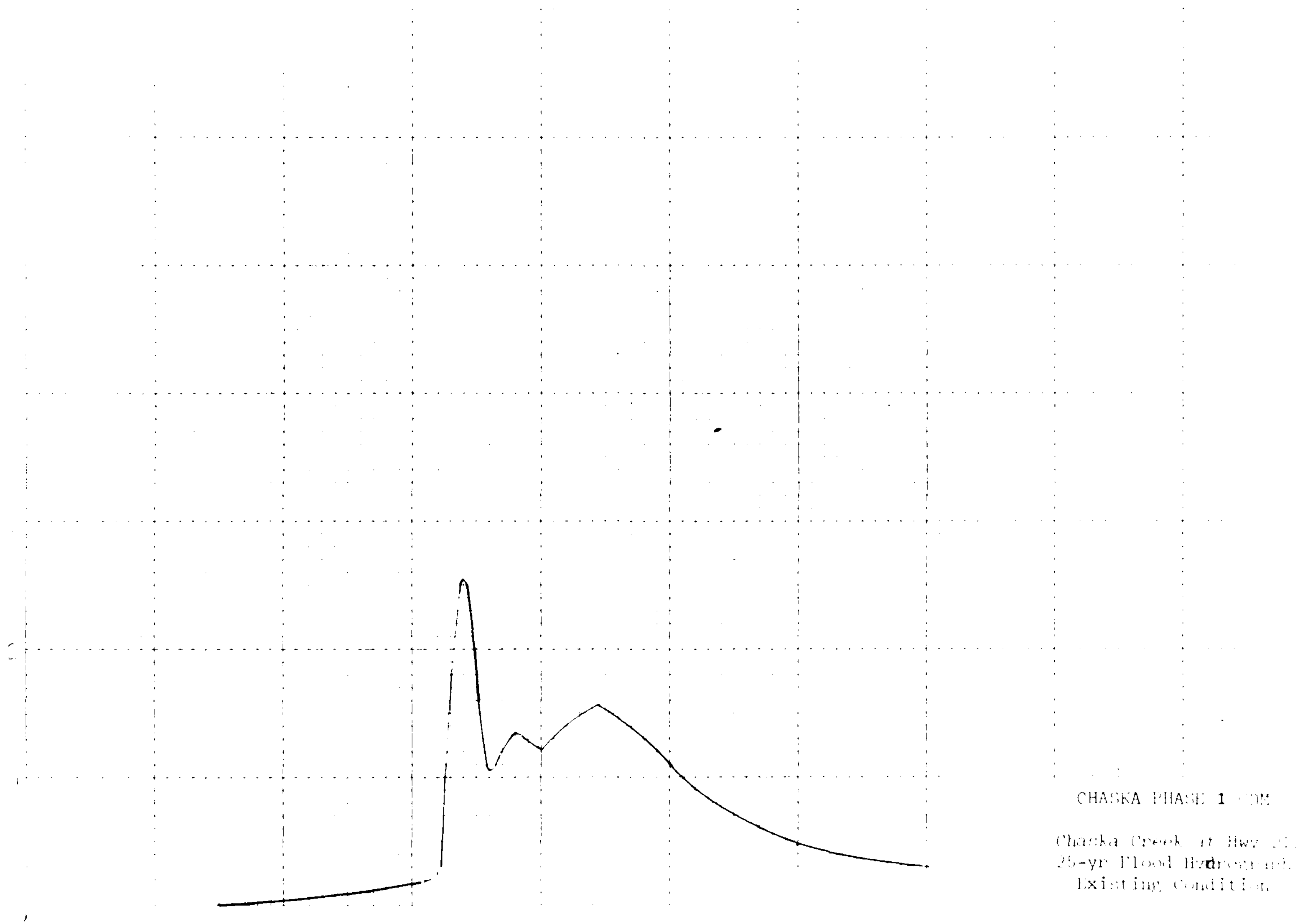
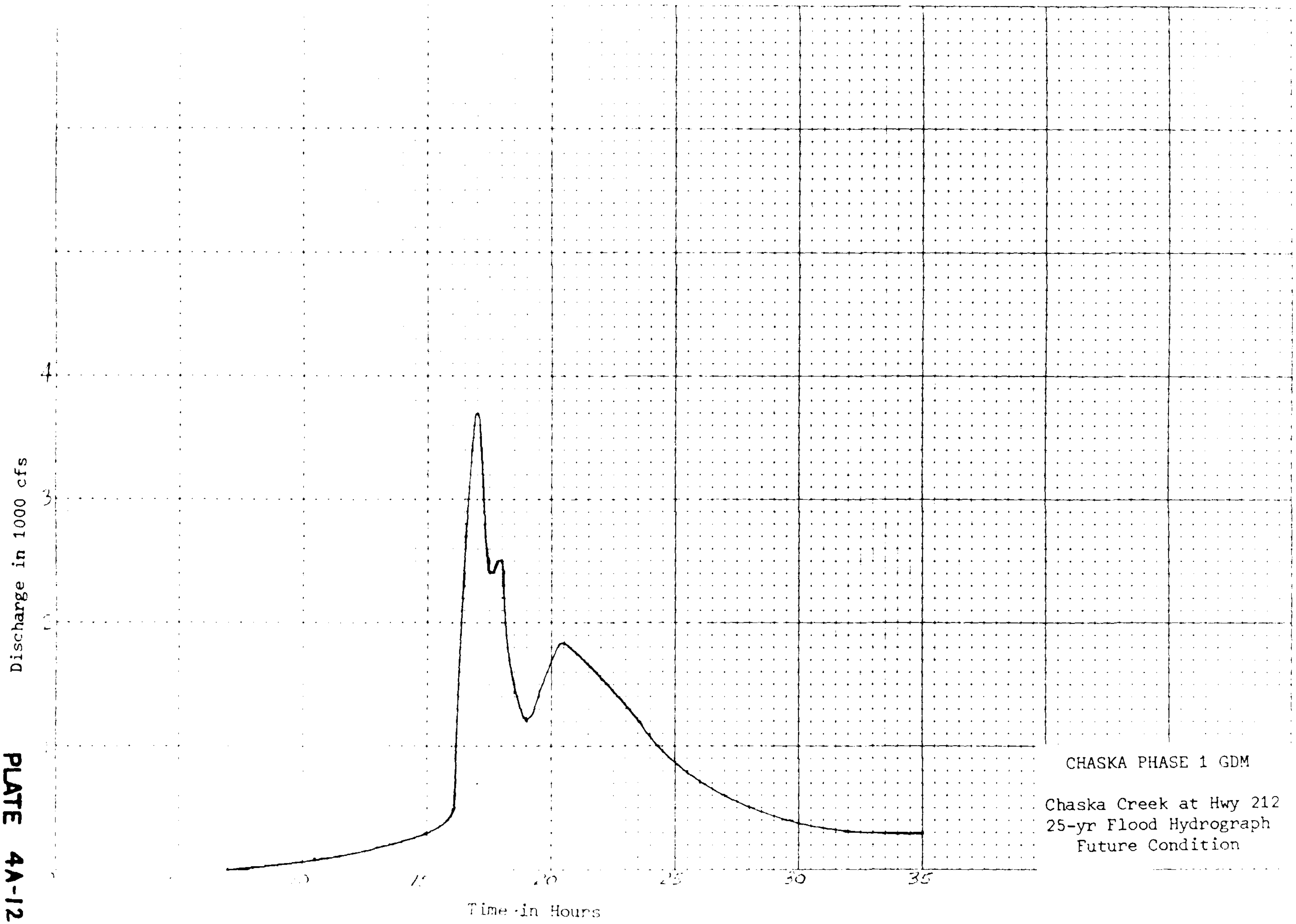

Discharge in 1000 cfs
CHASKA PHASE 1
Chaska Creek at Hwy
25-yr Flood
Existing

PLATE 4A-11



CHASKA PHASE 1 GDM
Chaska Creek at Hwy 212
25-yr Flood Hydrograph
Future Condition
Discharge in 1000 cfs
4
3
Time in Hours
20
30
35

PLATE 4A-12

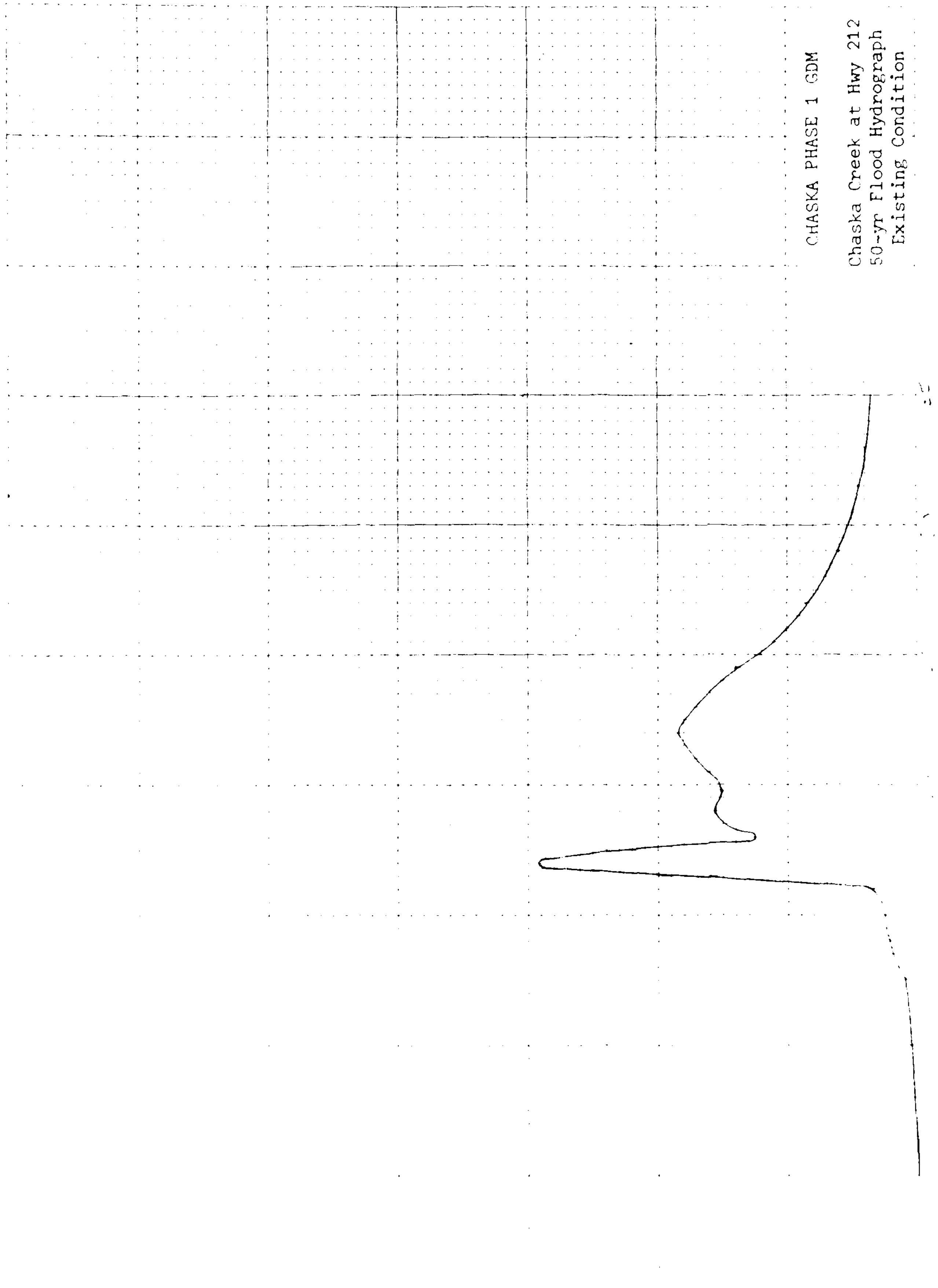
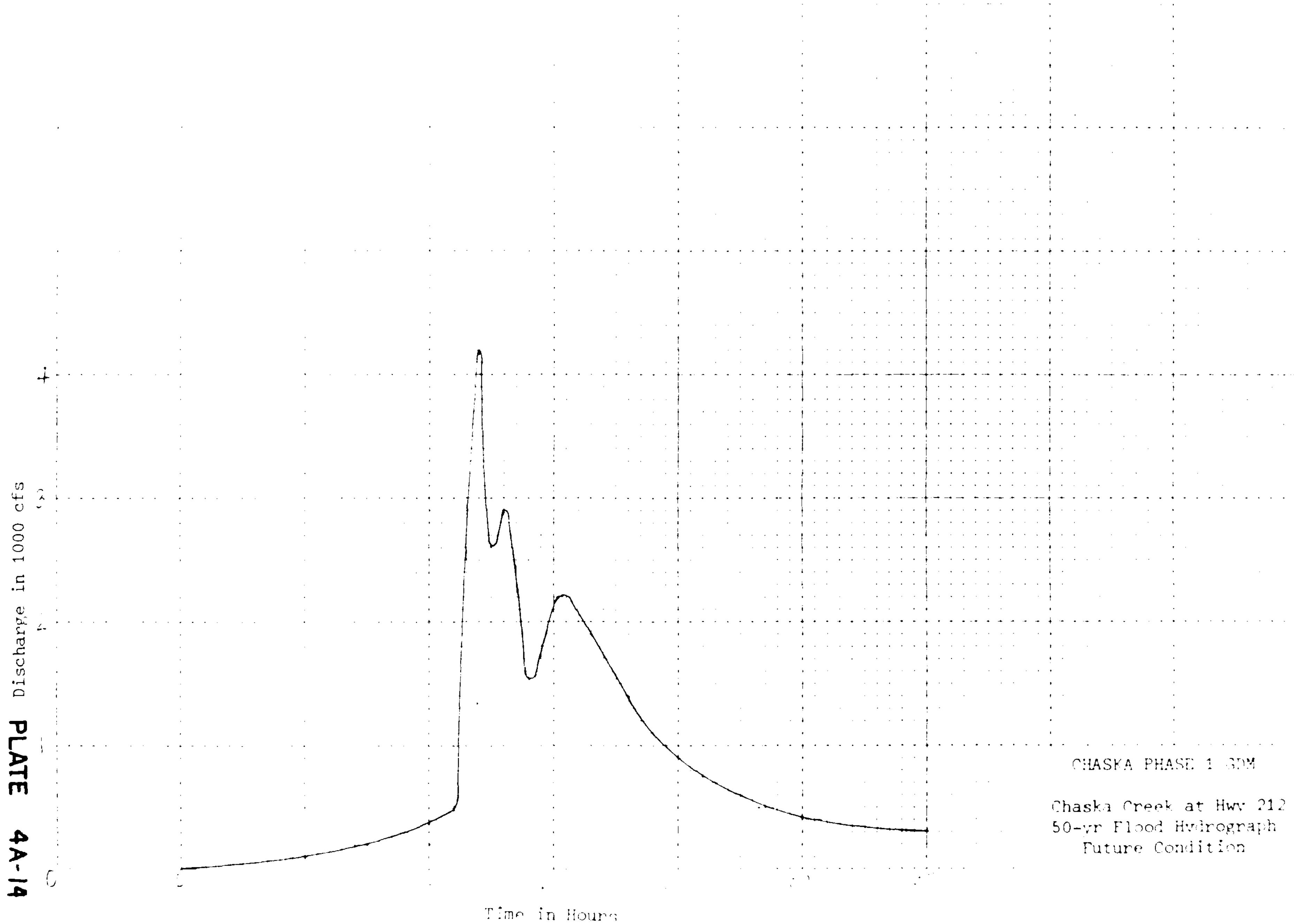

CHASKA PHASE 1 GDM
Chaska Creek at Hwy 212
50-yr Flood Hydrograph
Existing Condition
Time in Hours
Discharge in 1000 cfs

PLATE 4A-13



CHASKA PHASE 1 GDM

Chaska Creek at Hwy 212
50-yr Flood Hydrograph
Future Condition

PLATE 4A-14

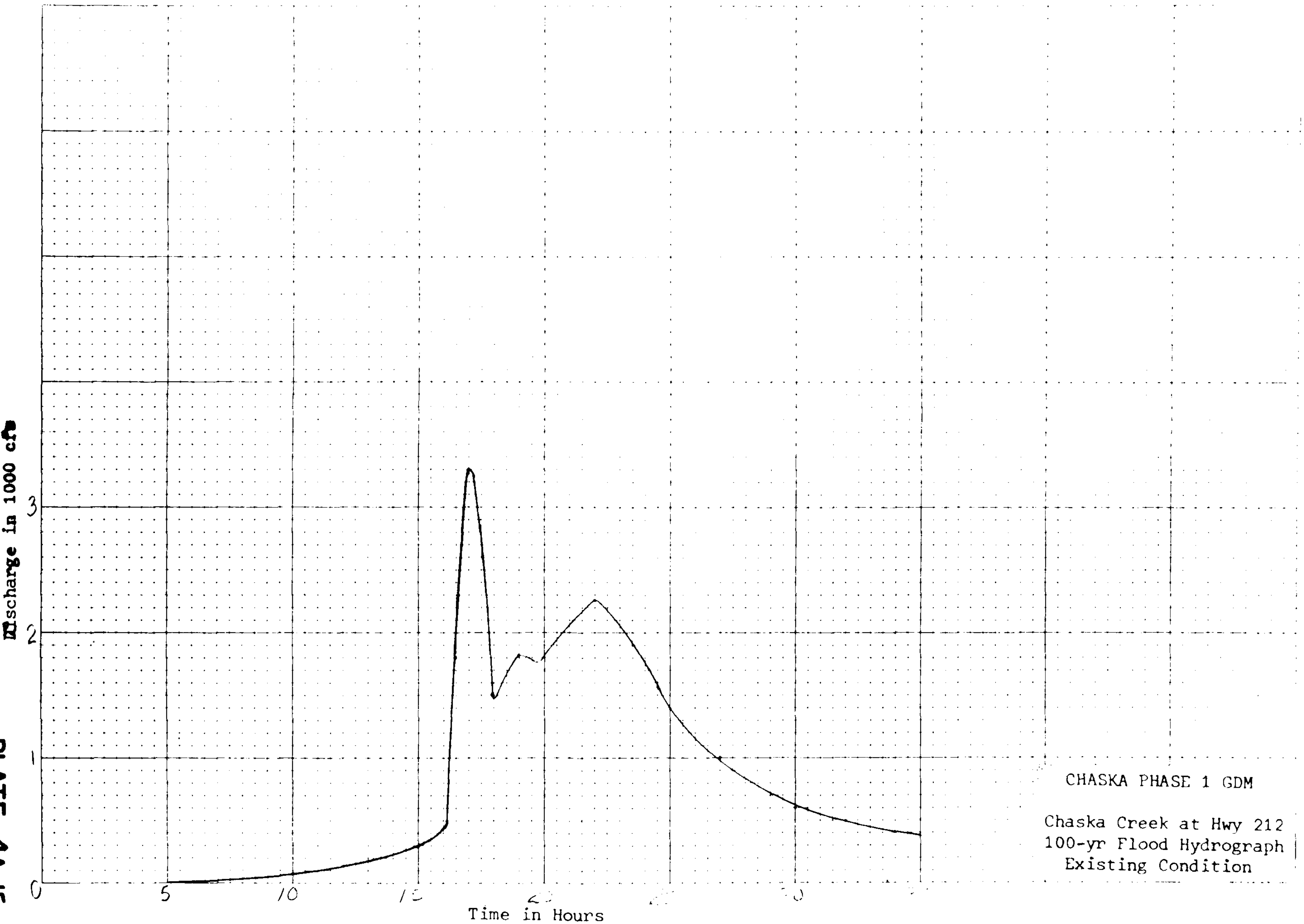

CHASKA PHASE 1 GDM
Chaska Creek at Hwy 212
100-yr Flood Hydrograph
Existing Condition
Discharge in 1000 cfs
Time in Hours
0
1
2
3
5
10

PLATE 4A-15

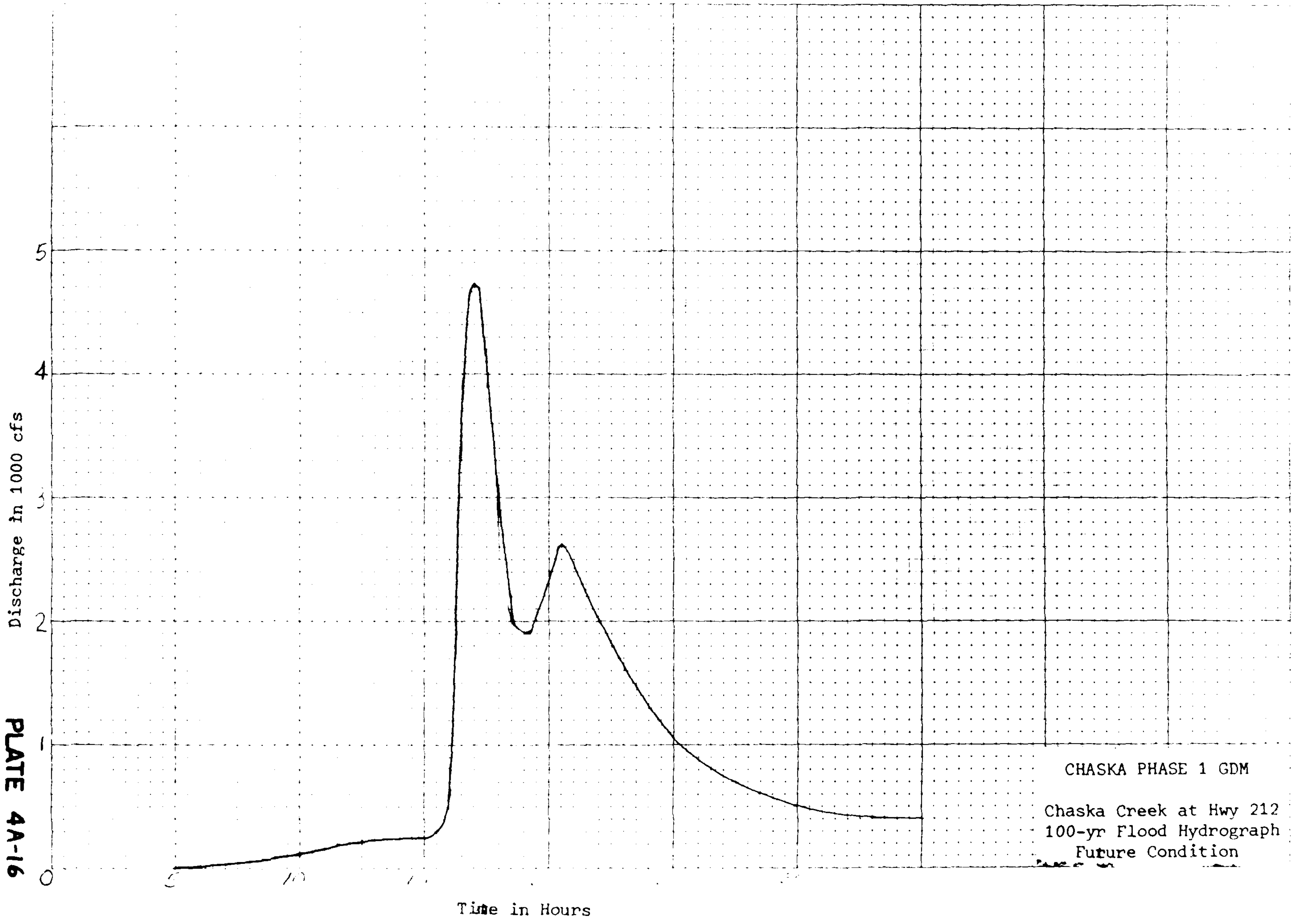
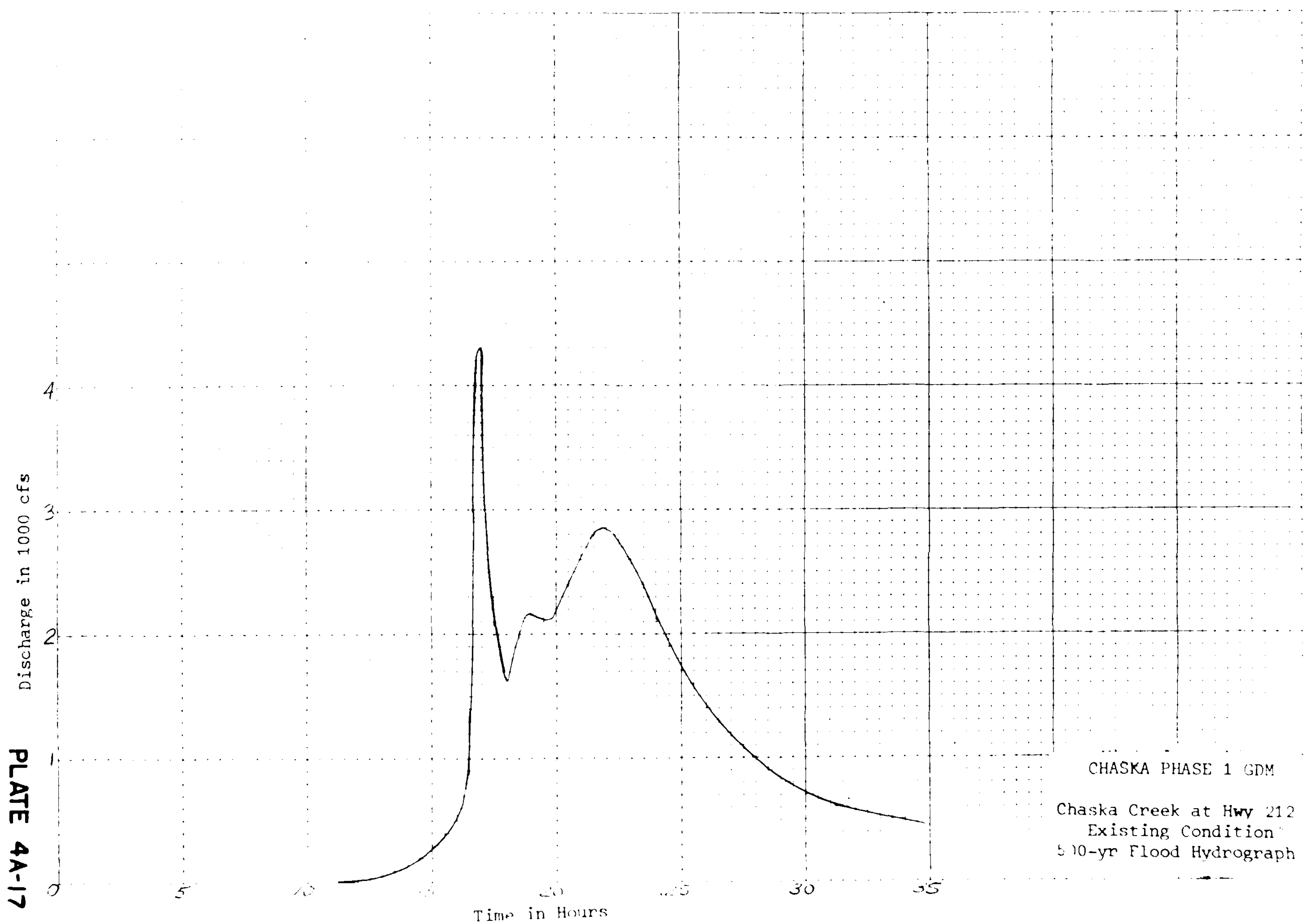

CHASKA PHASE 1 GDM
Chaska Creek at Hwy 212
100-yr Flood Hydrograph
Future Condition
Discharge in 1000 cfs
Time in Hours
0
1
2
3
4
5

PLATE 4A-16



CHASKA PHASE 1 GDM

Chaska Creek at Hwy 212
Existing Condition
500-yr Flood Hydrograph

PLATE 4A-17

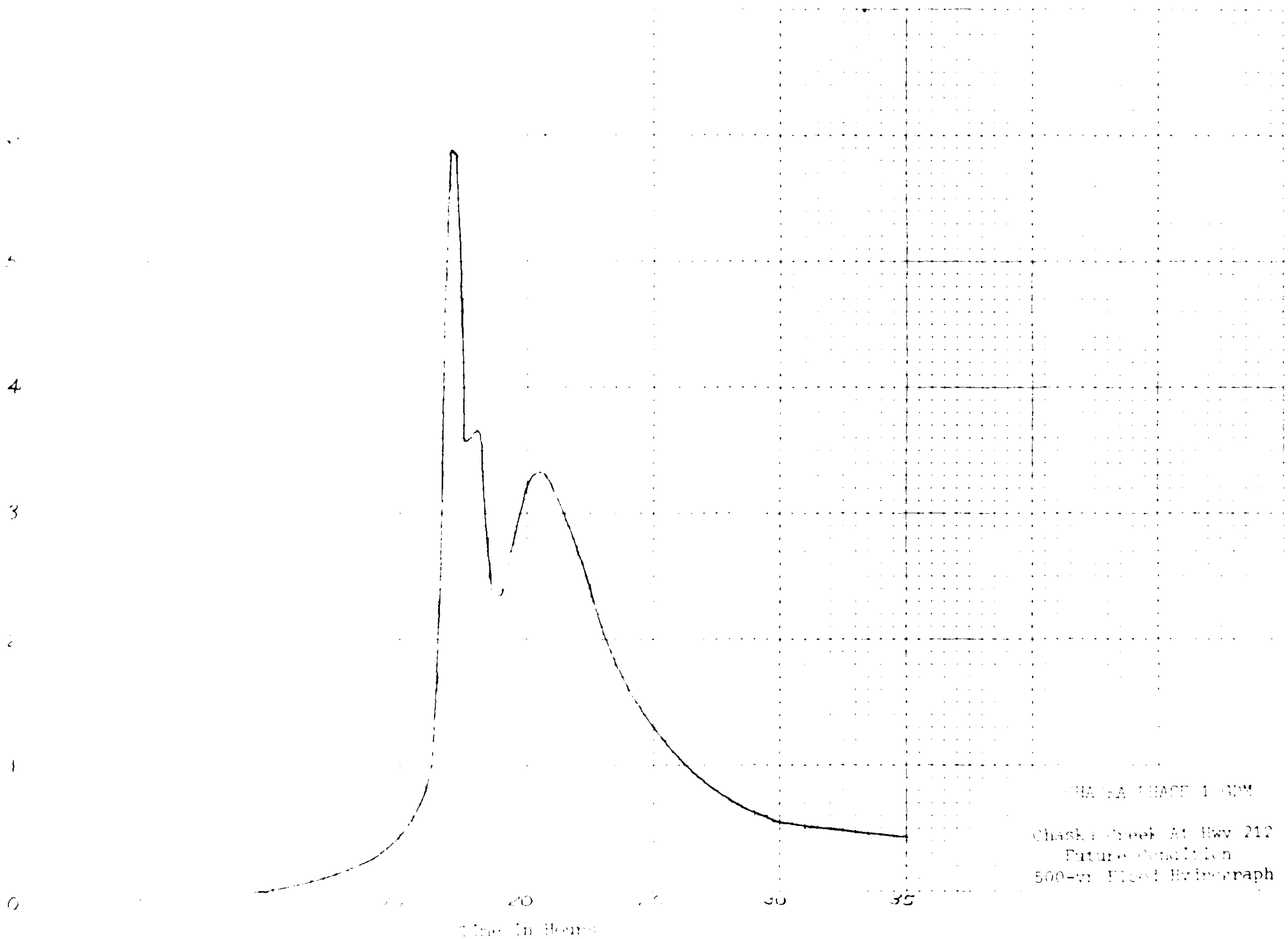
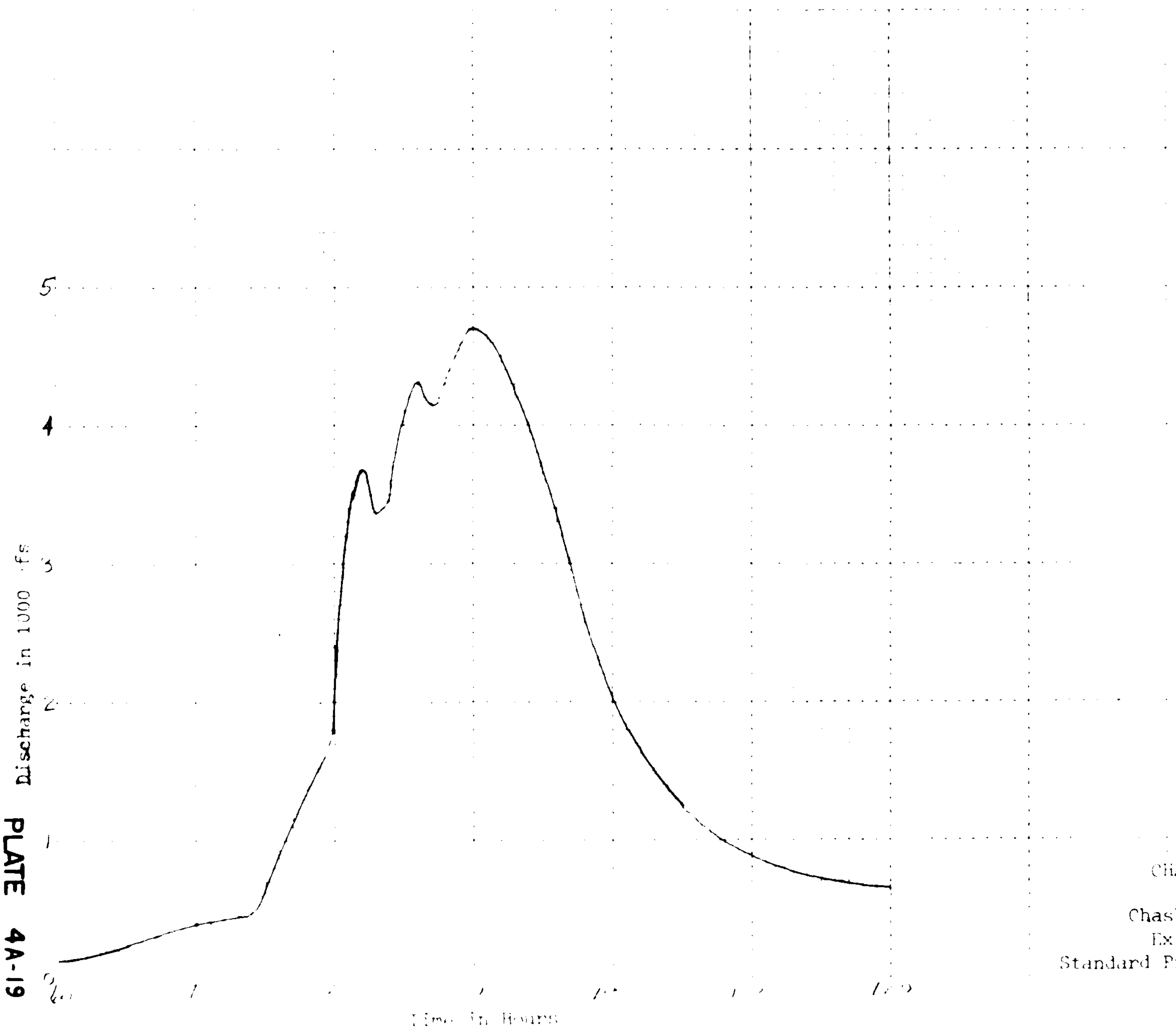

Chaska Creek At Hwy 212
Future Condition
500-yr Flood Hydrograph
Time In Hours
0
1
3
4
20
30
35

PLATE 4A-18



CHASKA PHASE I GDM

Chaska Creek at Hwy 212
Existing Conditions
Standard Project Flood Hydrograph

PLATE 4A-19

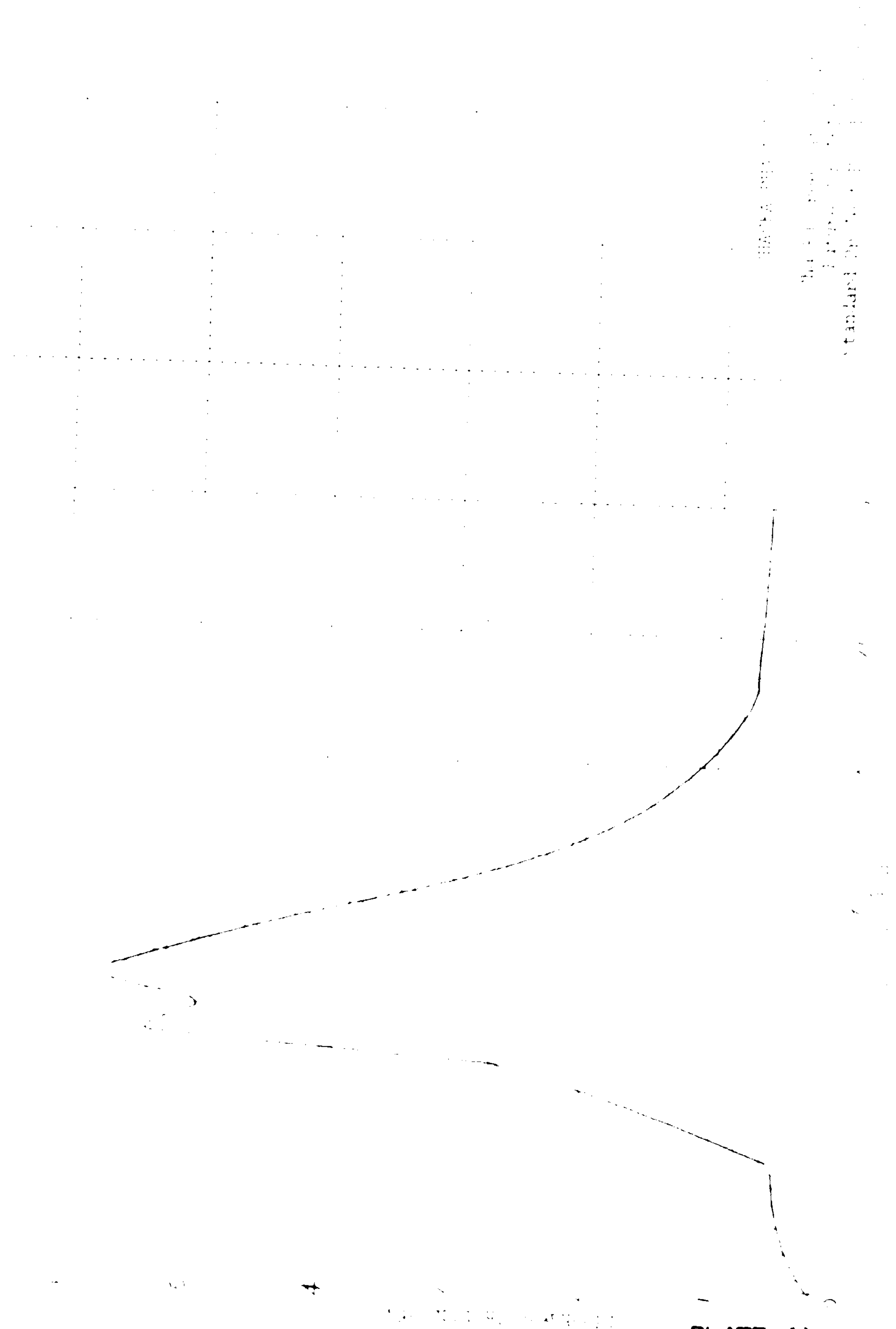


PLATE 4A-20

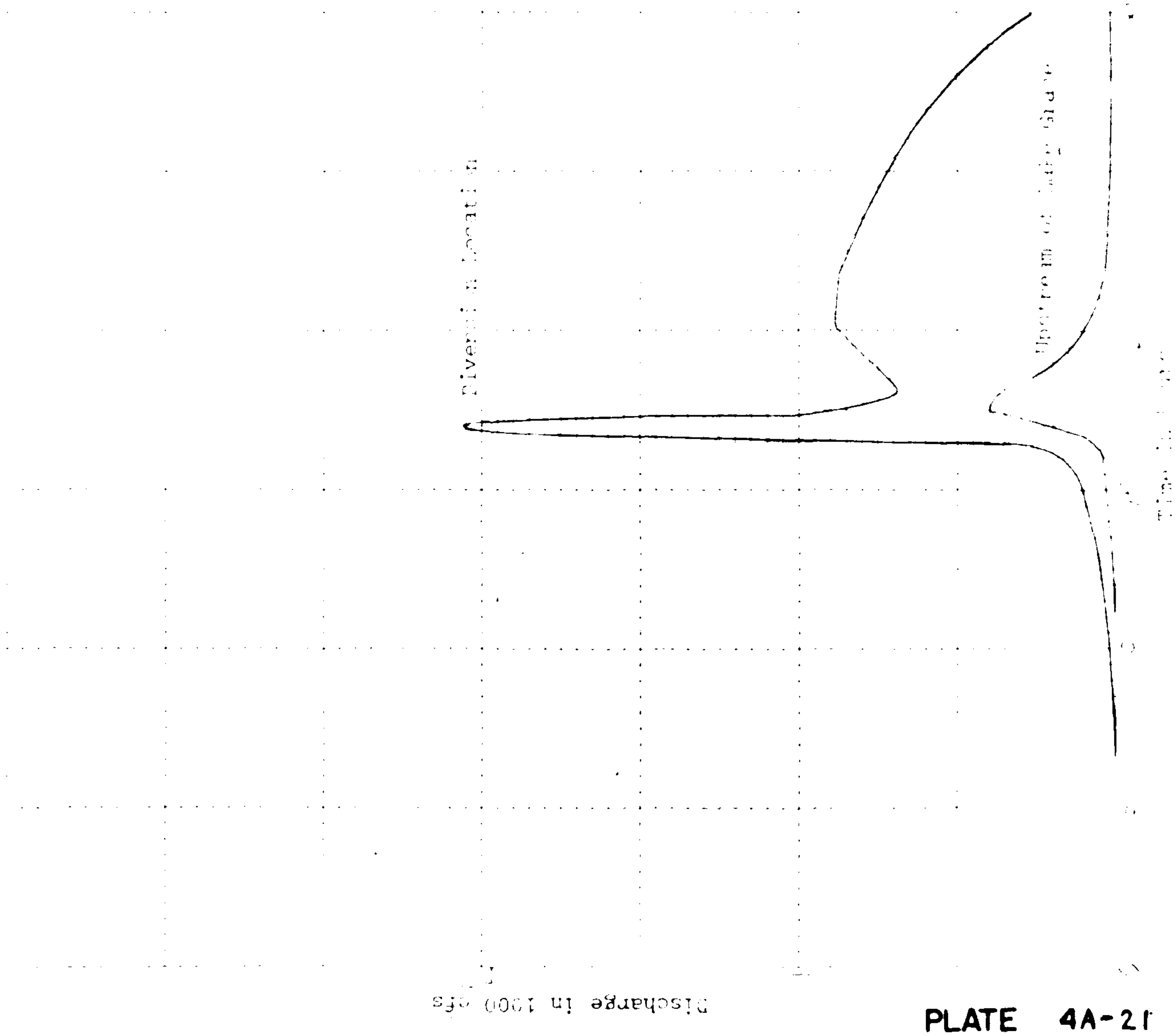
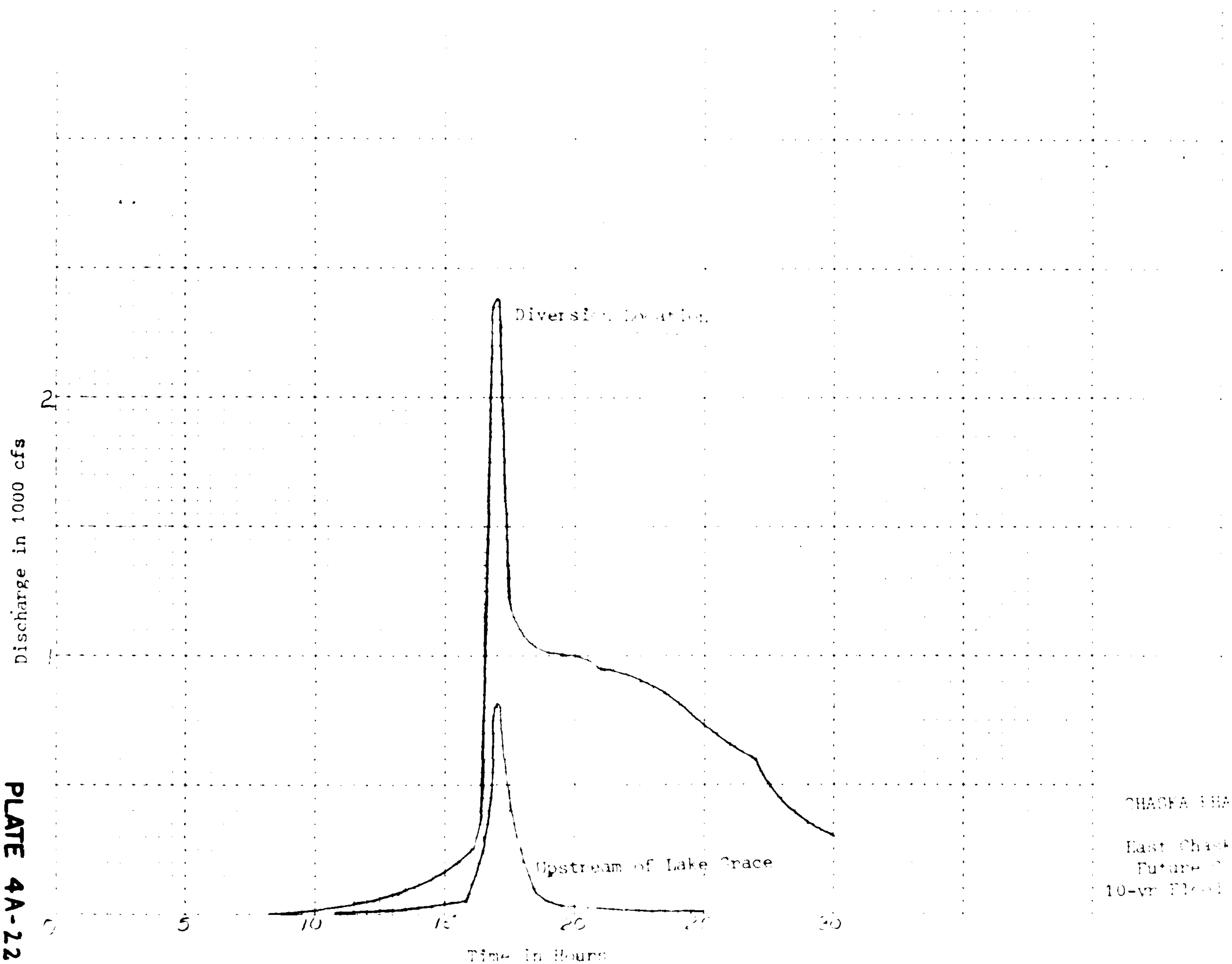


PLATE 4A-21



CHASKA [illegible]

East Chaska [illegible]
Future [illegible]
10-yr [illegible]

PLATE 4A-22

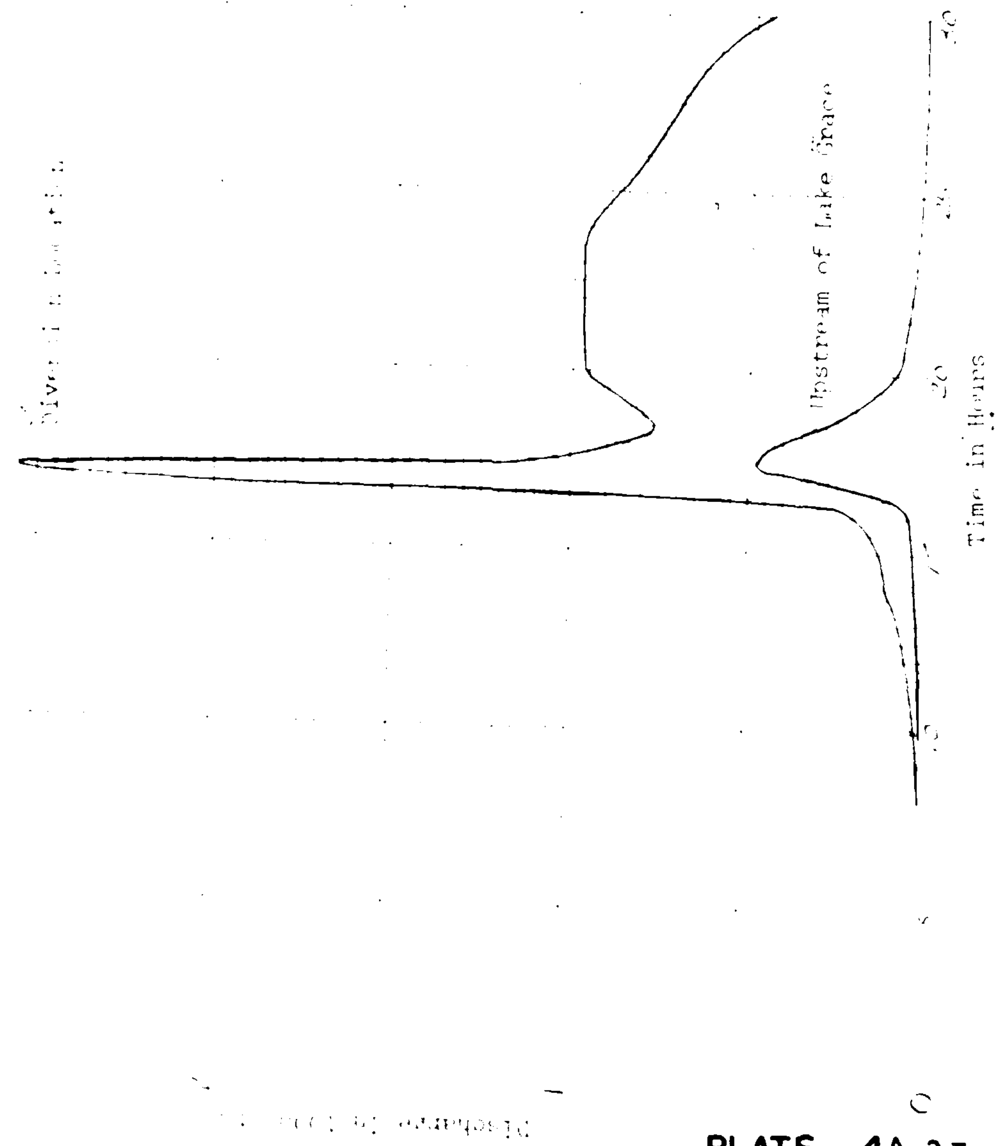


PLATE 4A-23

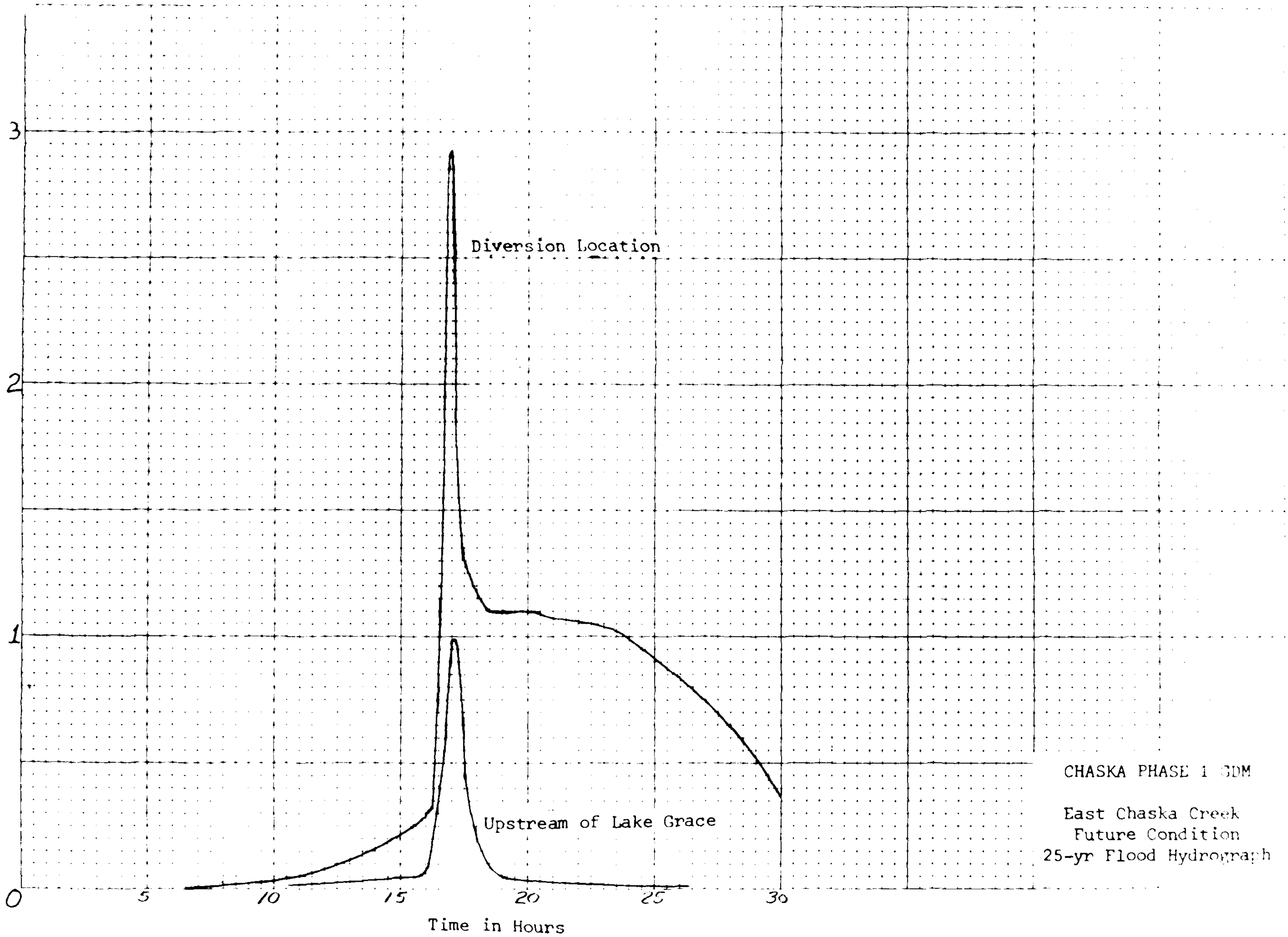

CHASKA PHASE 1 GDM
East Chaska Creek
Future Condition
25-yr Flood Hydrograph
Diversion Location
Upstream of Lake Grace
Time in Hours
0
5
10
15
20
25
30
1
2
3

PLATE 4A-24

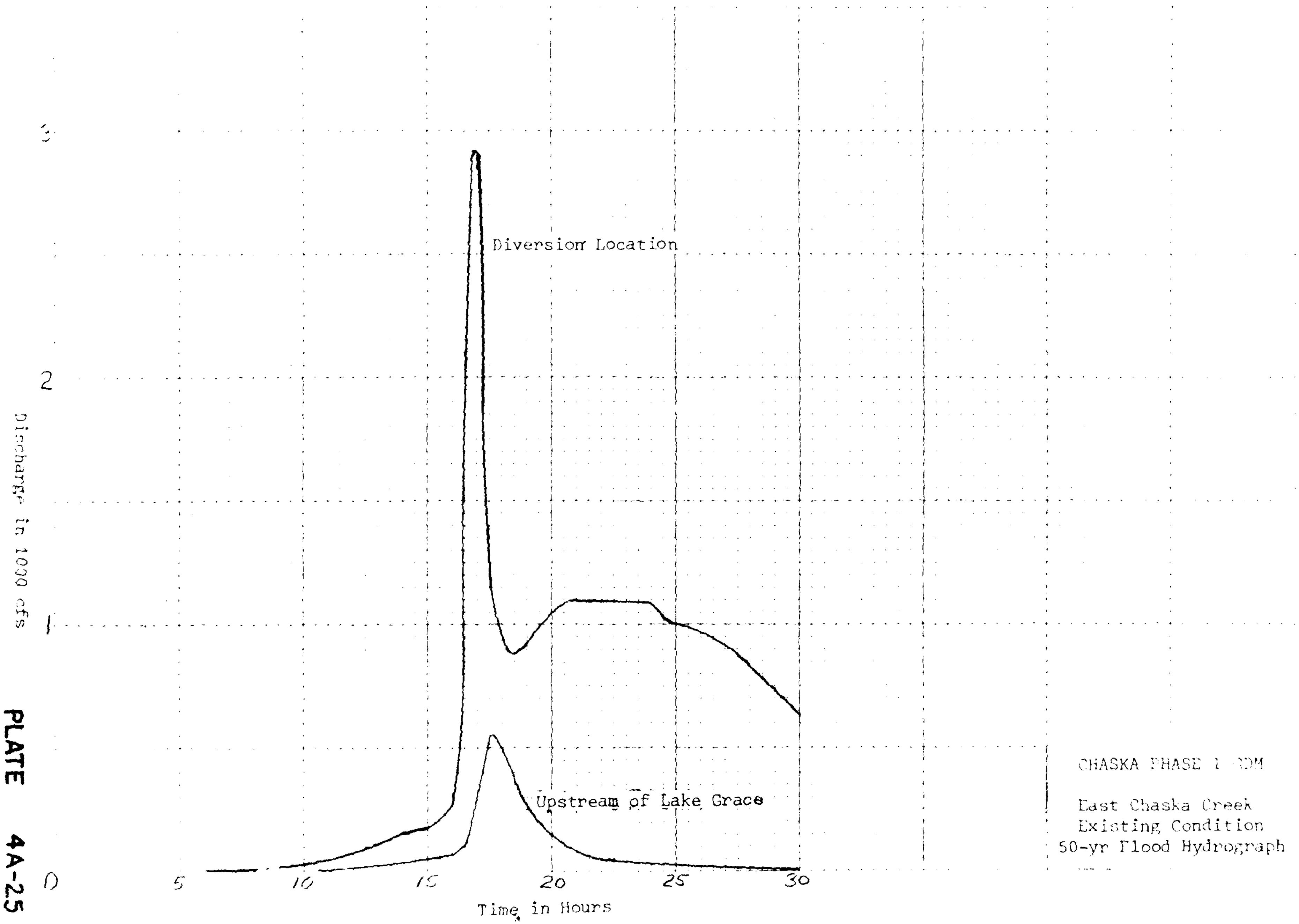
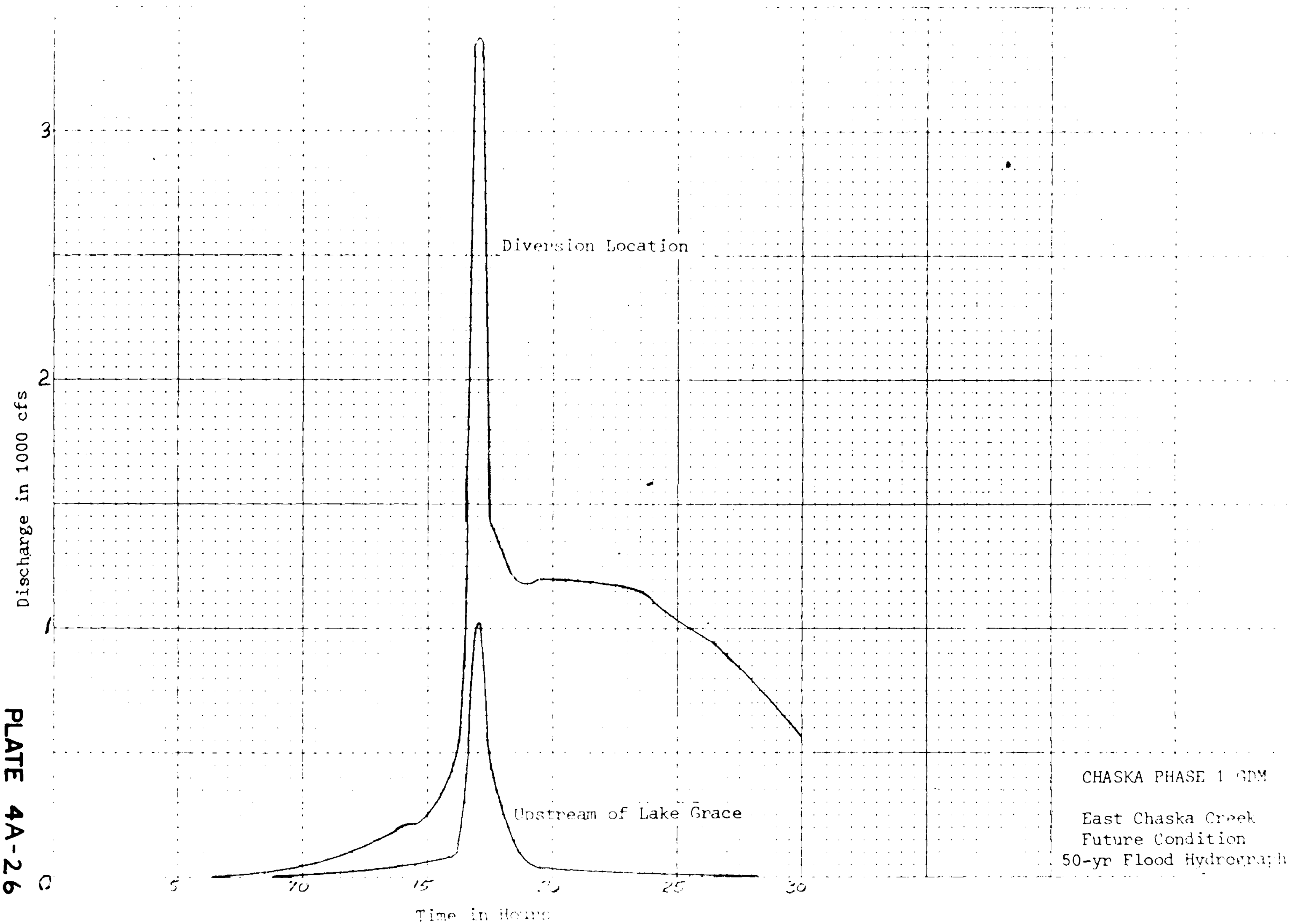

3
2
1
0
Discharge in 1000 cfs
5
10
15
20
25
30
Time in Hours
Diversion Location
Upstream of Lake Grace
CHASKA PHASE I GDM
East Chaska Creek
Existing Condition
50-yr Flood Hydrograph

PLATE 4A-25



Diversion Location
Upstream of Lake Grace
Discharge in 1000 cfs
Time in Hours
0
1
2
3
5
10
15
20
25
30
CHASKA PHASE 1 GDM
East Chaska Creek
Future Condition
50-yr Flood Hydrograph

PLATE 4A-26

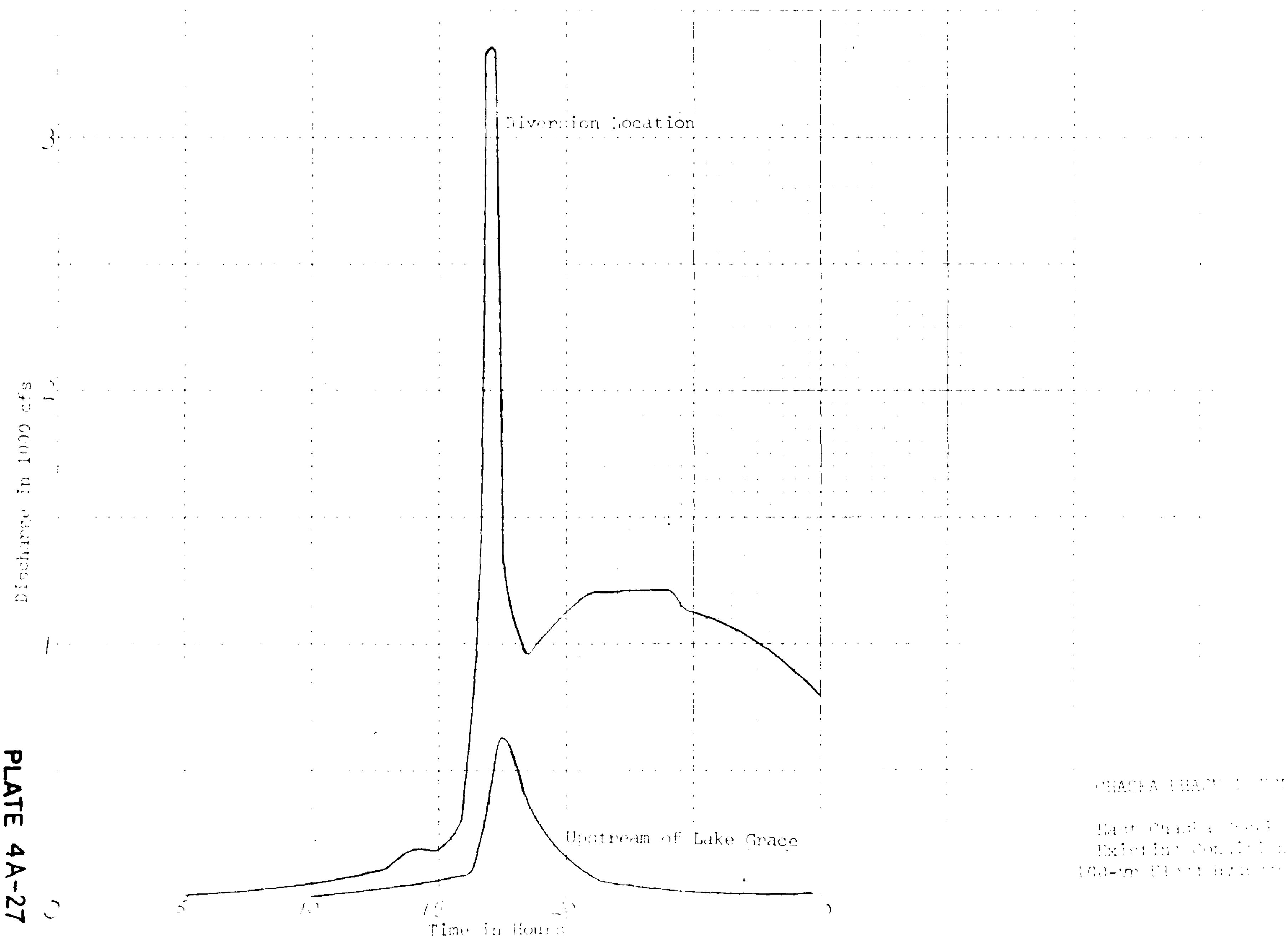

Diversion Location
Upstream of Lake Grace
Discharge in 1000 cfs
Time in Hours
3
1

PLATE 4A-27

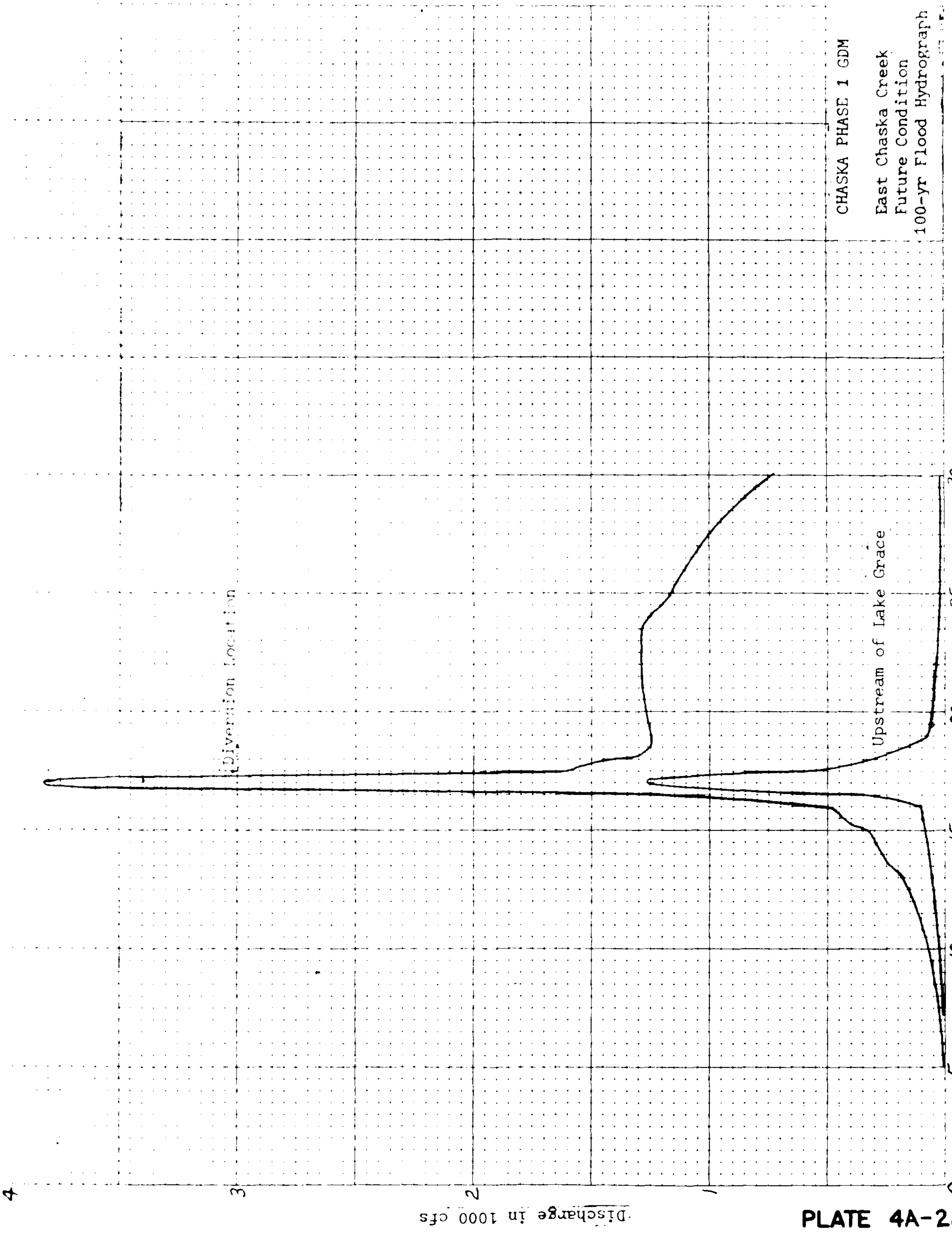
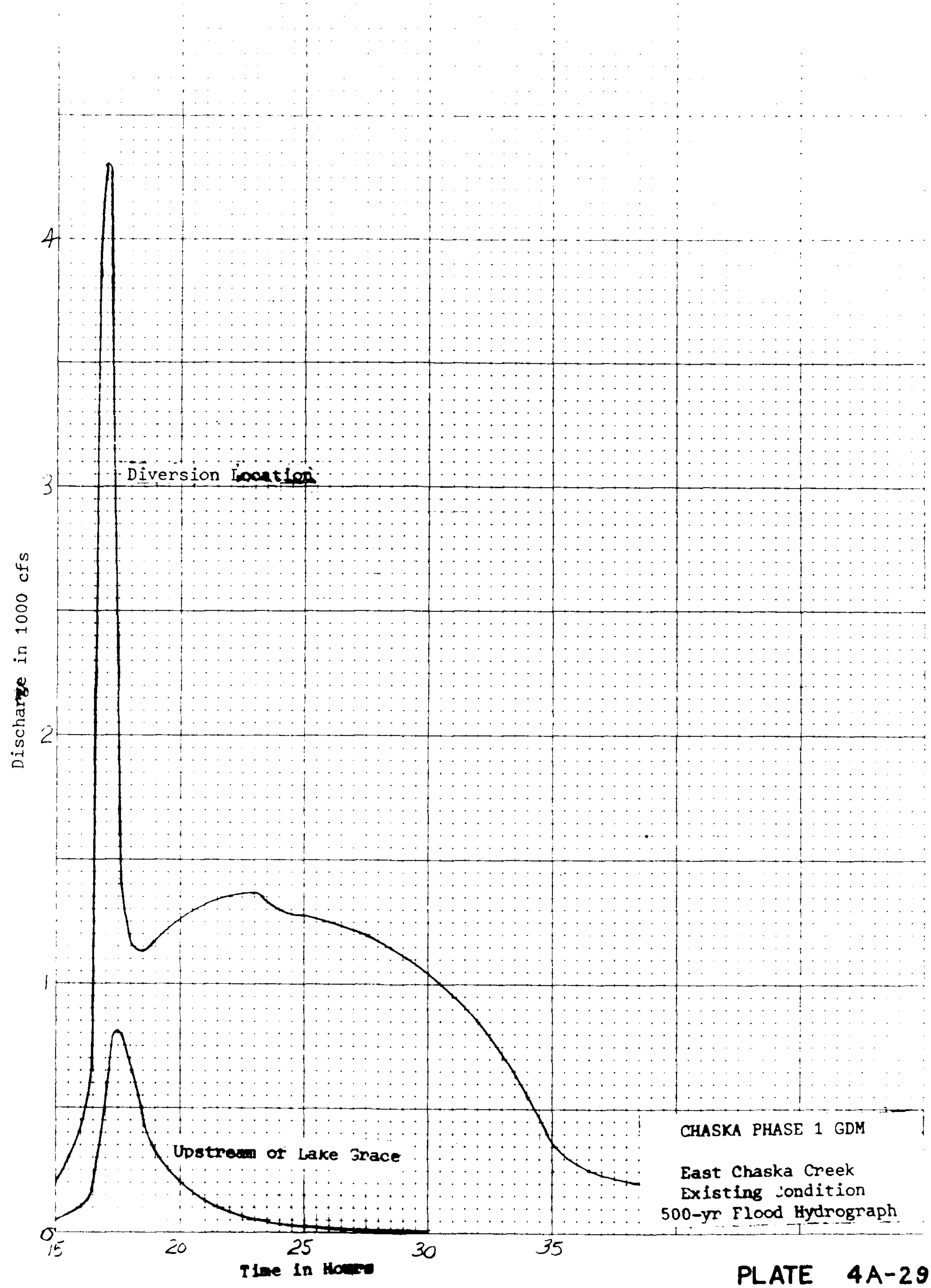
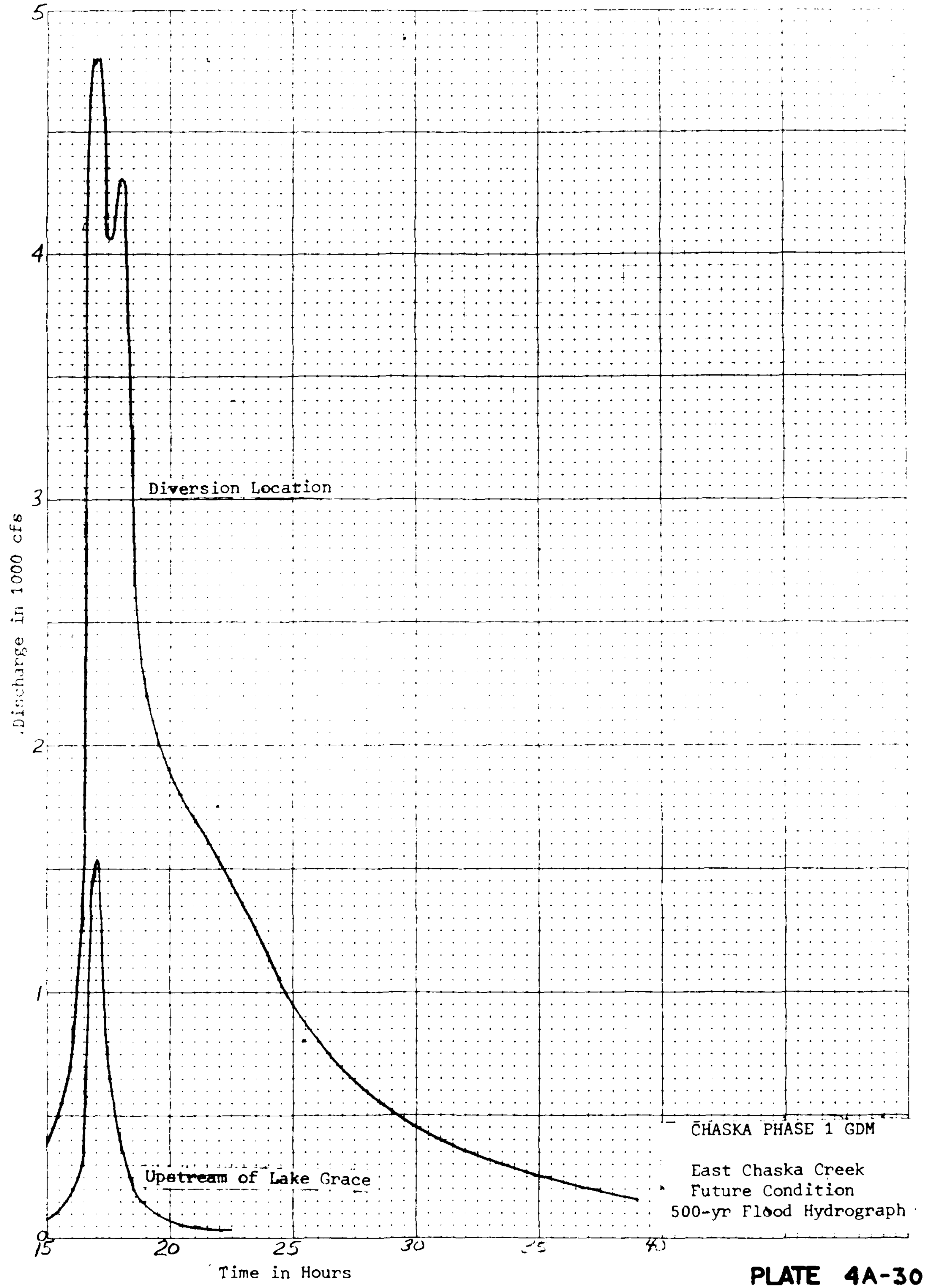

CHASKA PHASE 1 GDM
East Chaska Creek
Future Condition
100-yr Flood Hydrograph
Diversion Location
Upstream of Lake Grace
Time In Hours
Discharge in 1000 cfs
0
5
10
15
20
25
30
1
2
3
4

PLATE 4A-28



Diversion Location
Upstream of Lake Grace
Discharge in 1000 cfs
Time in Hours
0
1
2
3
4
15
20
25
30
35
CHASKA PHASE 1 GDM
East Chaska Creek
Existing Condition
500-yr Flood Hydrograph

PLATE 4A-29



5
4
3
2
1
0
Discharge in 1000 cfs
Diversion Location
Upstream of Lake Grace
15
20
25
30
40
Time in Hours
CHASKA PHASE 1 GDM
East Chaska Creek
Future Condition
500-yr Flood Hydrograph

PLATE 4A-30

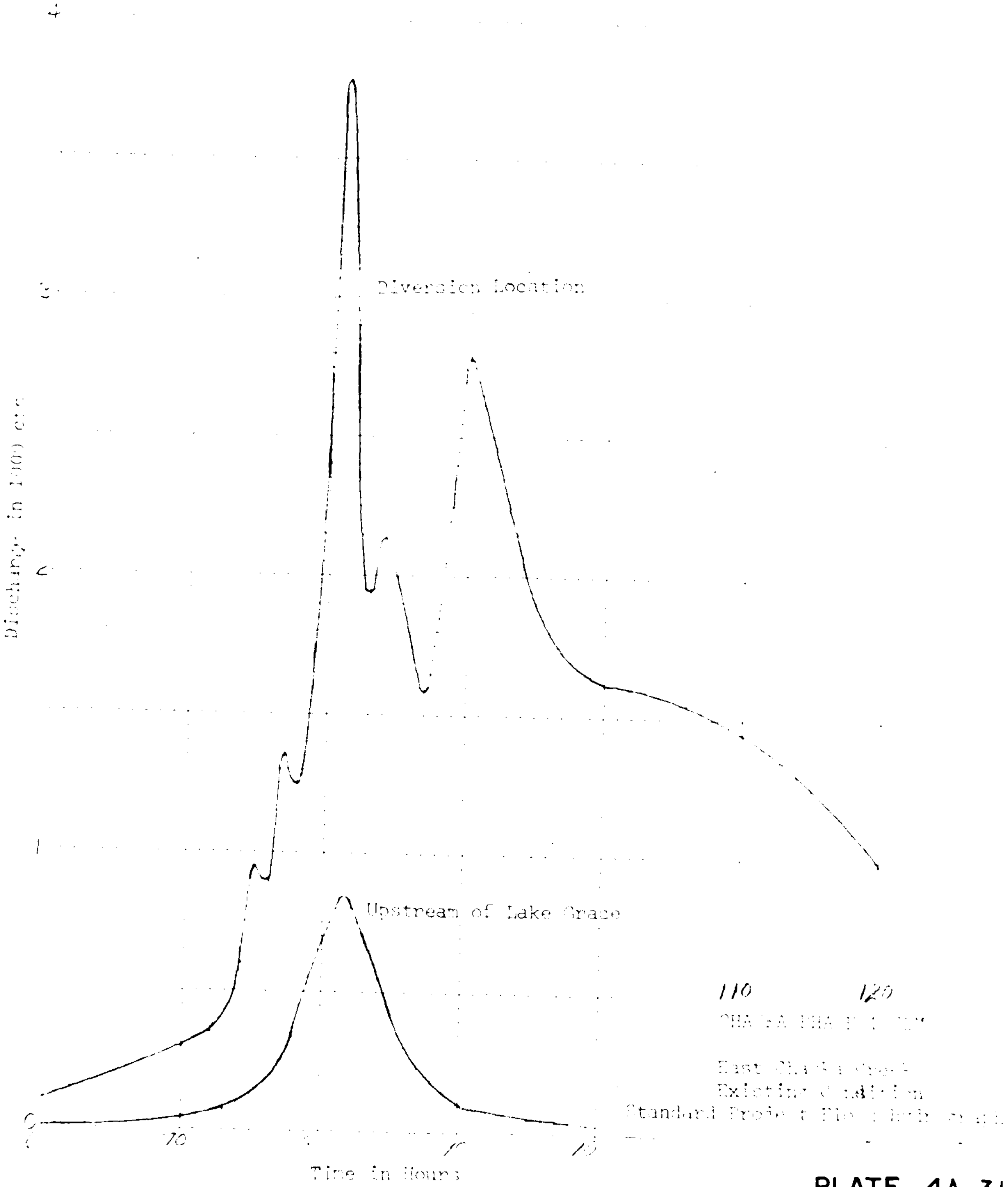
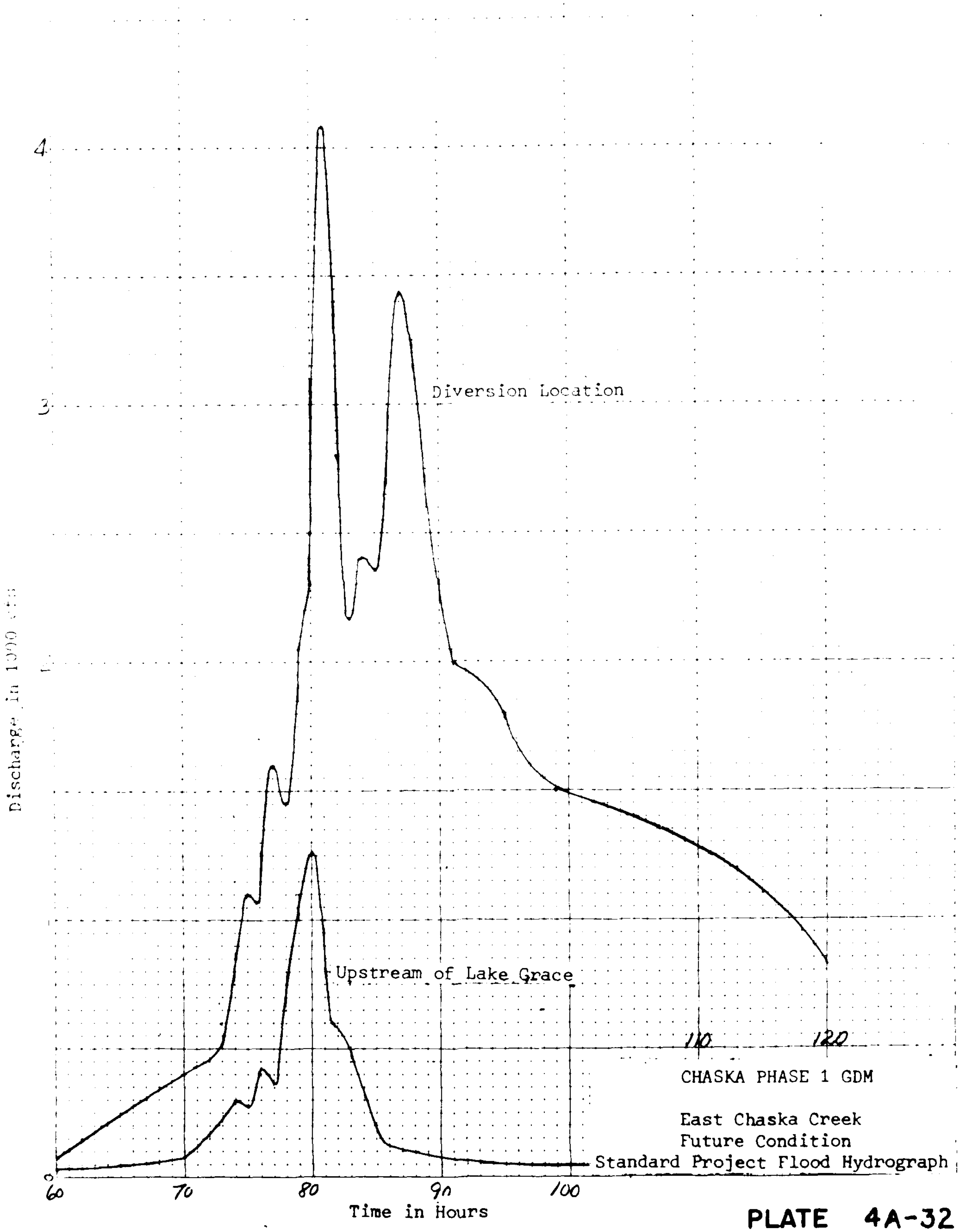
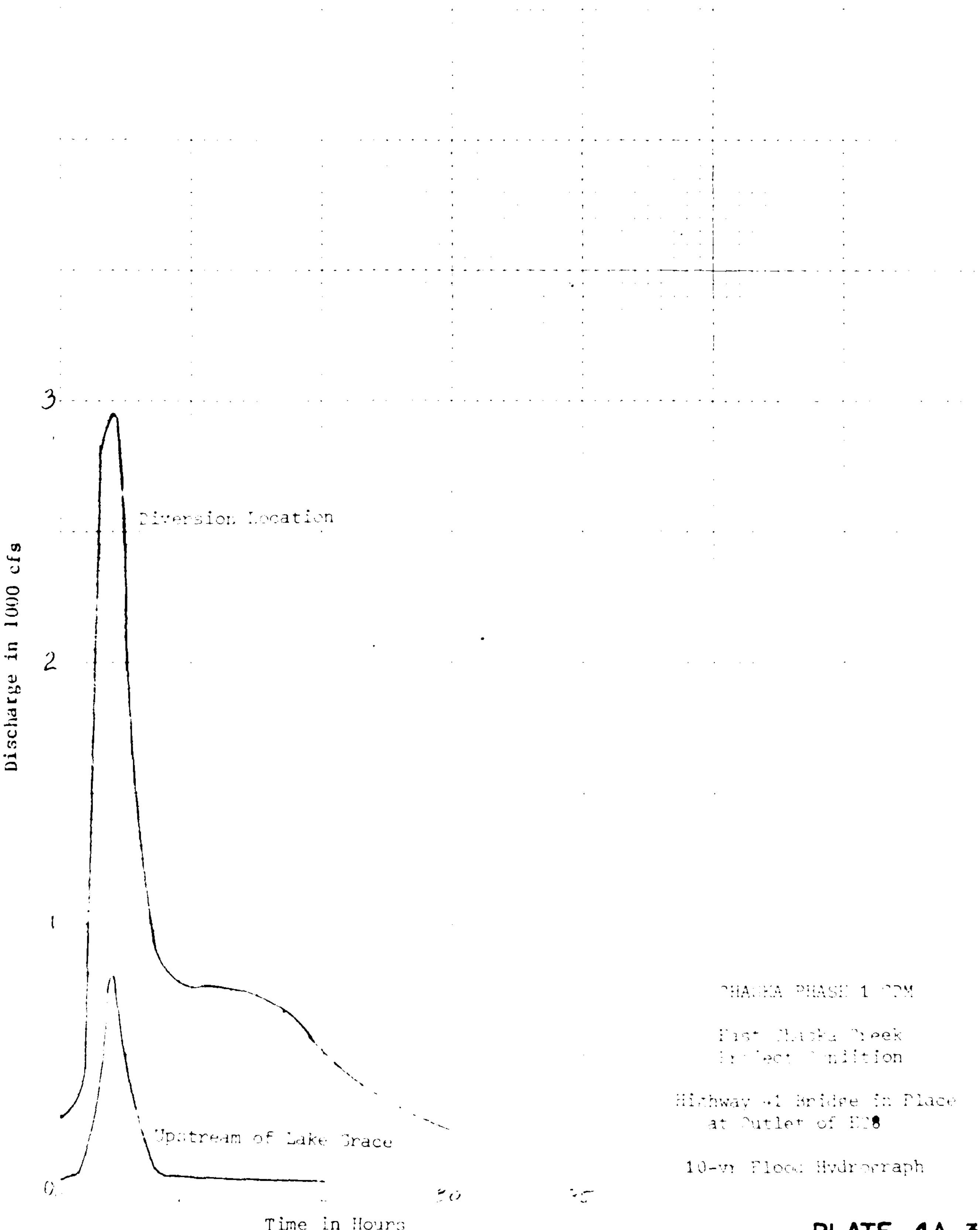

Diversion Location
Upstream of Lake Grace
Time in Hours
110
120

PLATE 4A-31



4
3
Diversion Location
Upstream of Lake Grace
Discharge in 1000 cfs
0
60
70
80
90
100
110
120
Time in Hours
CHASKA PHASE 1 GDM
East Chaska Creek
Future Condition
Standard Project Flood Hydrograph

PLATE 4A-32



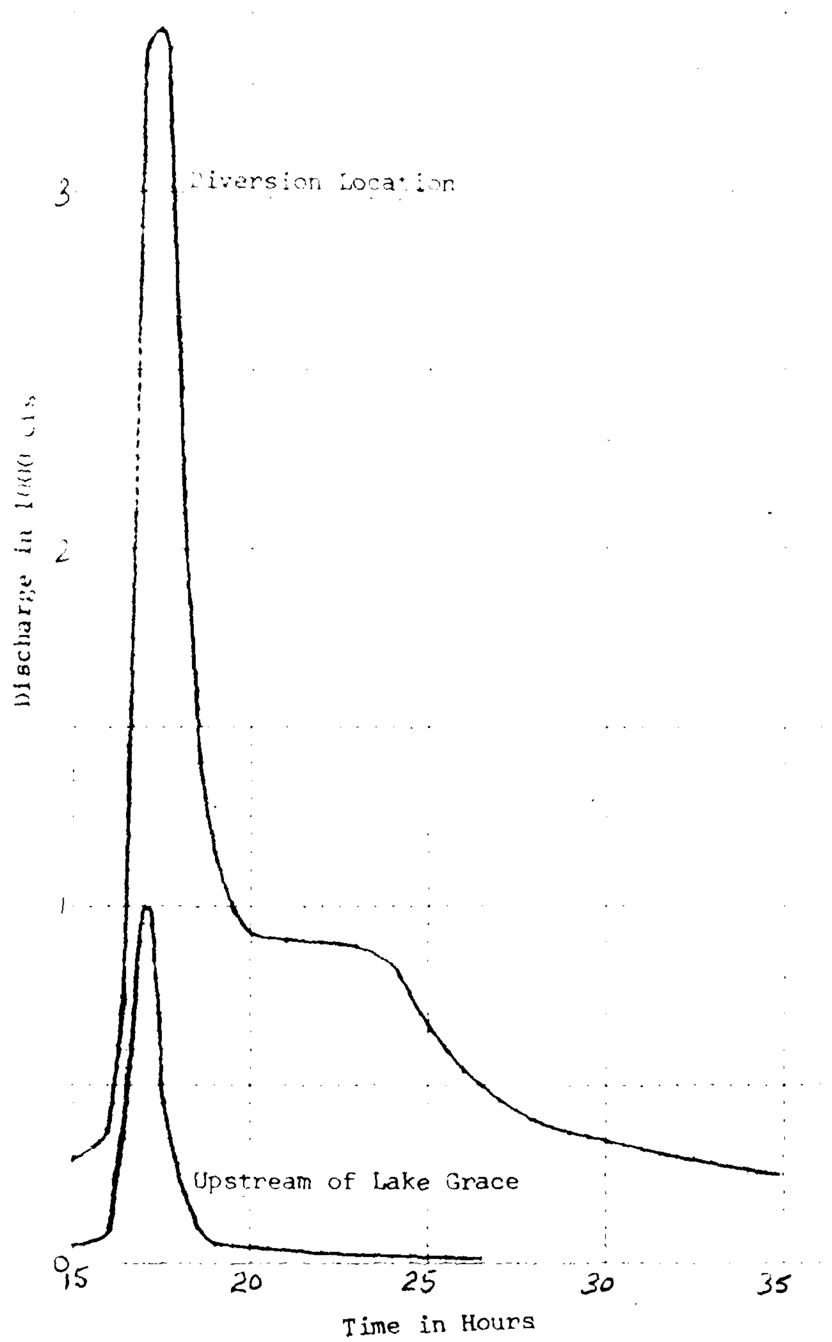
CHASKA PHASE 1 GDM

East Chaska Creek
Project Condition

Highway 41 Bridge in Place
at Outlet of E28

10-yr Flood Hydrograph

PLATE 4A-33



CHASKA PHASE 1 GDM

East Chaska Creek
Project Condition

Highway 41 Bridge in Place
at Outlet of EC8

25-yr Flood Hydrograph

PLATE 4A-34

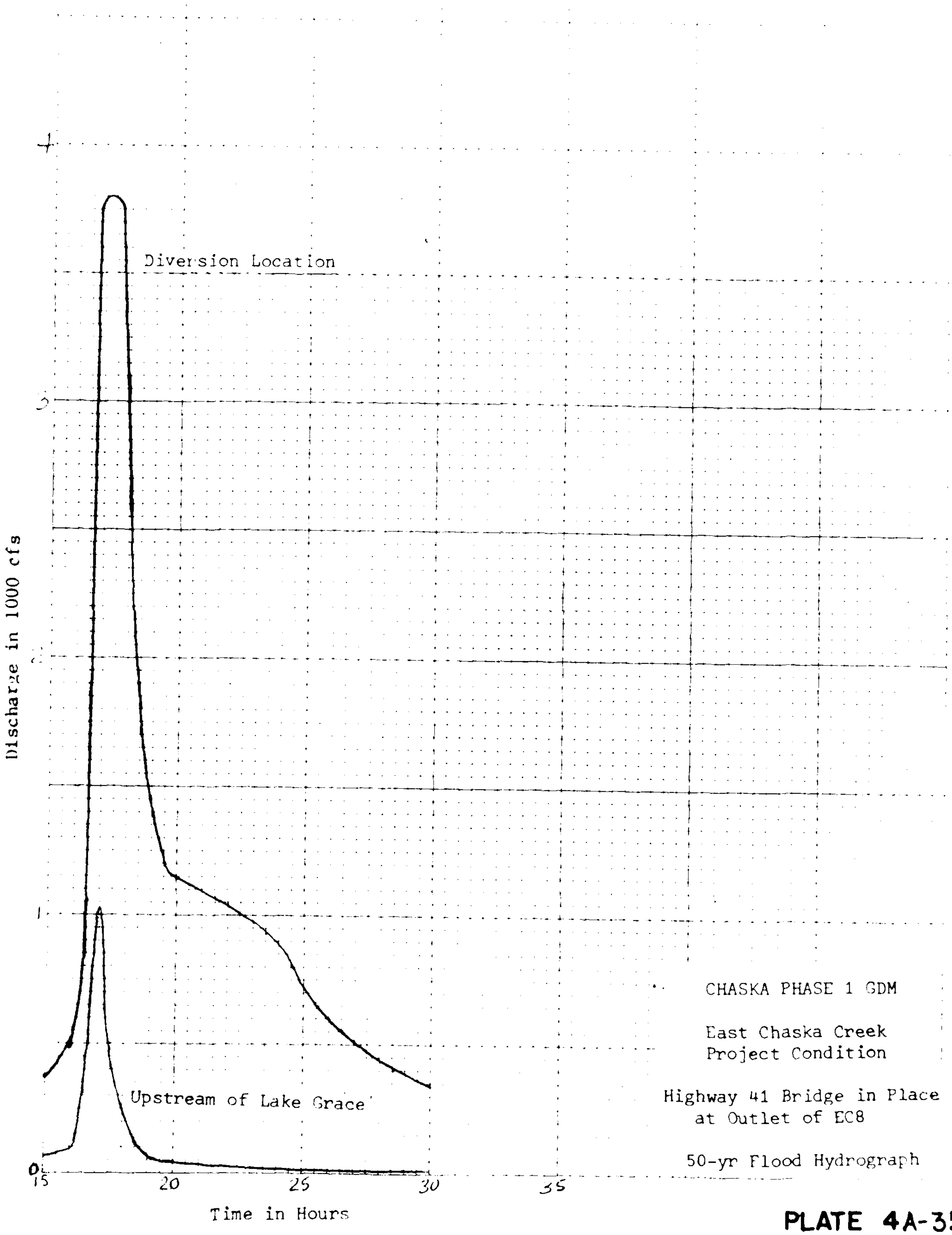
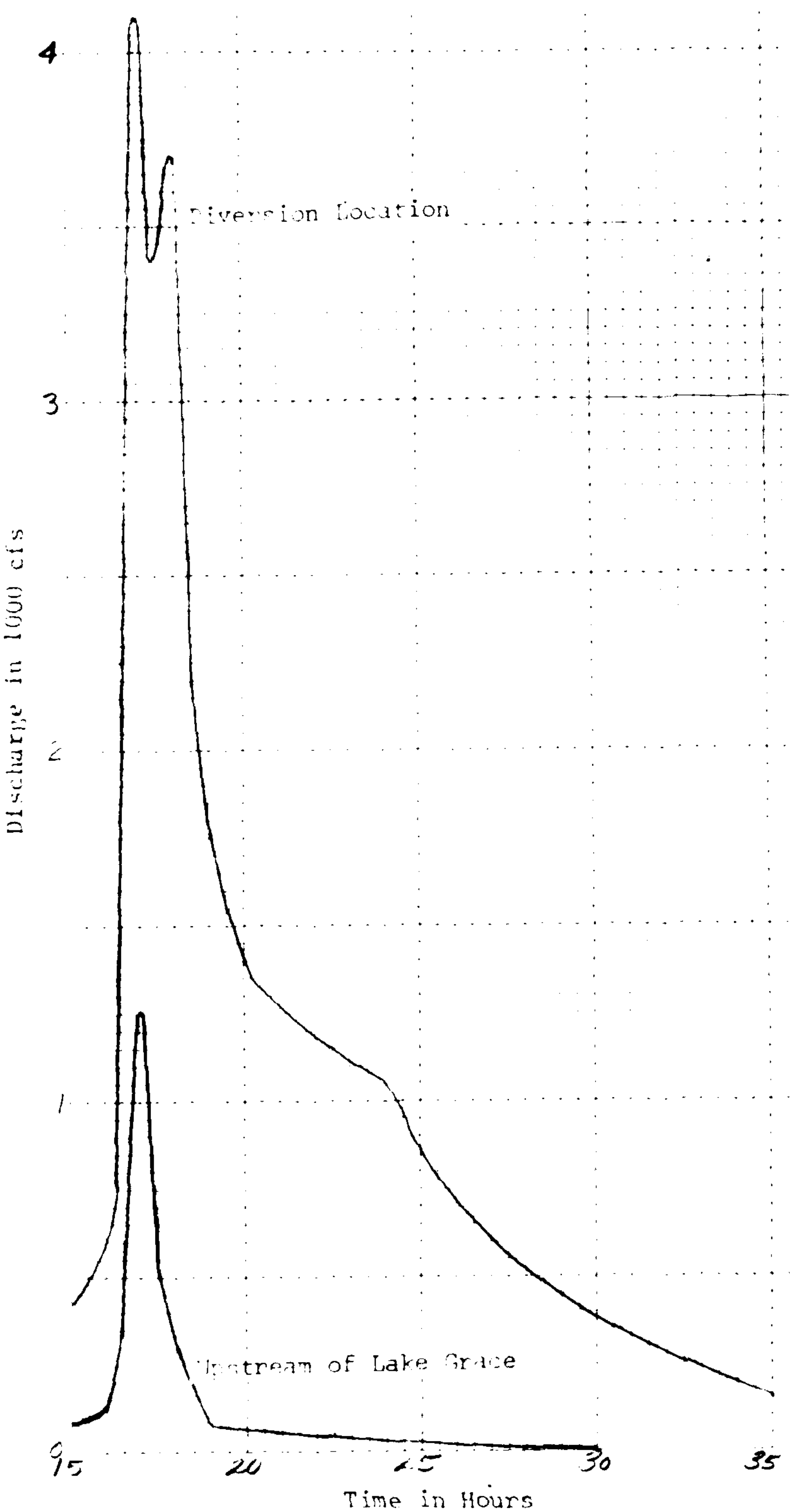

Diversion Location
Upstream of Lake Grace
Discharge in 1000 cfs
Time in Hours
0
1
2
3
4
15
20
25
30
35
CHASKA PHASE 1 GDM
East Chaska Creek
Project Condition
Highway 41 Bridge in Place
at Outlet of EC8
50-yr Flood Hydrograph

PLATE 4A-35



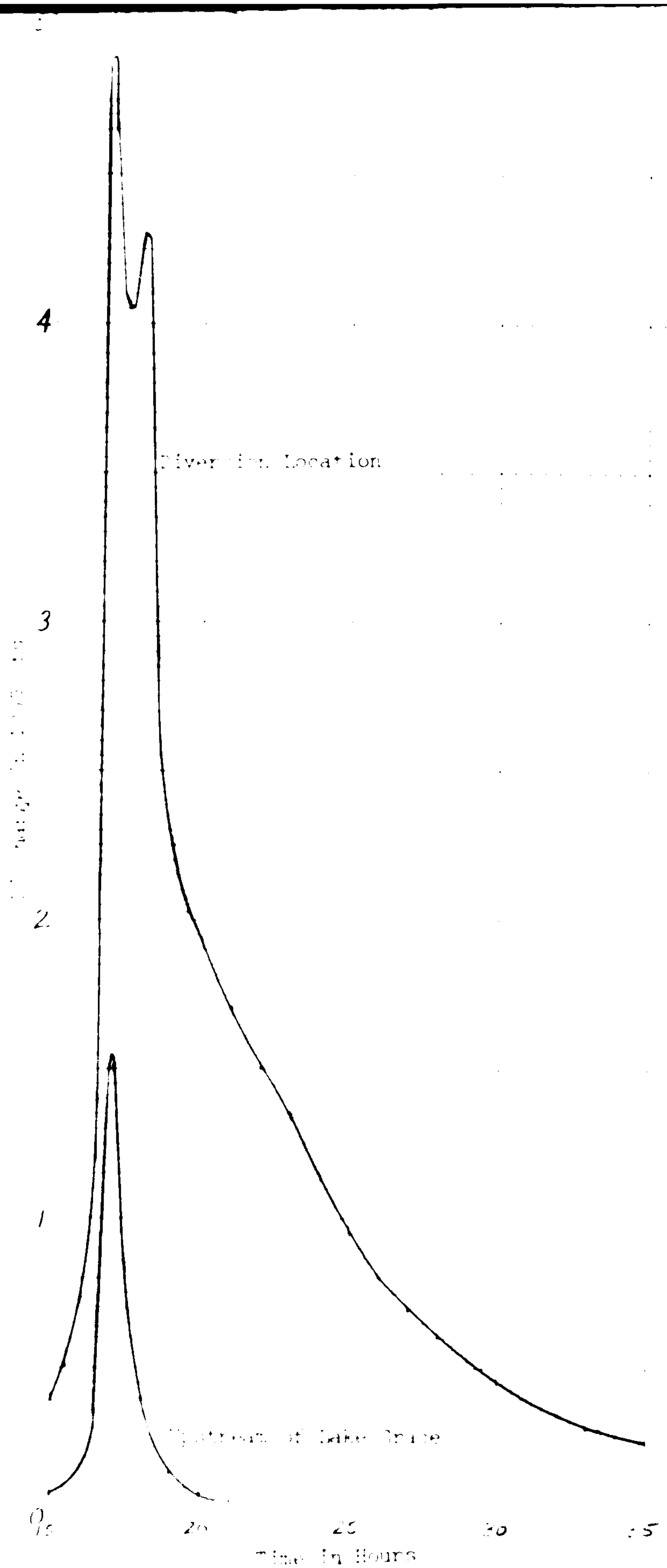
CHASKA PHASE 1 GDM

East Chaska Creek
Project Condition

Highway 41 Bridge in Place
at Outlet of EC8

100-yr Flood Hydrograph

PLATE 4A-36



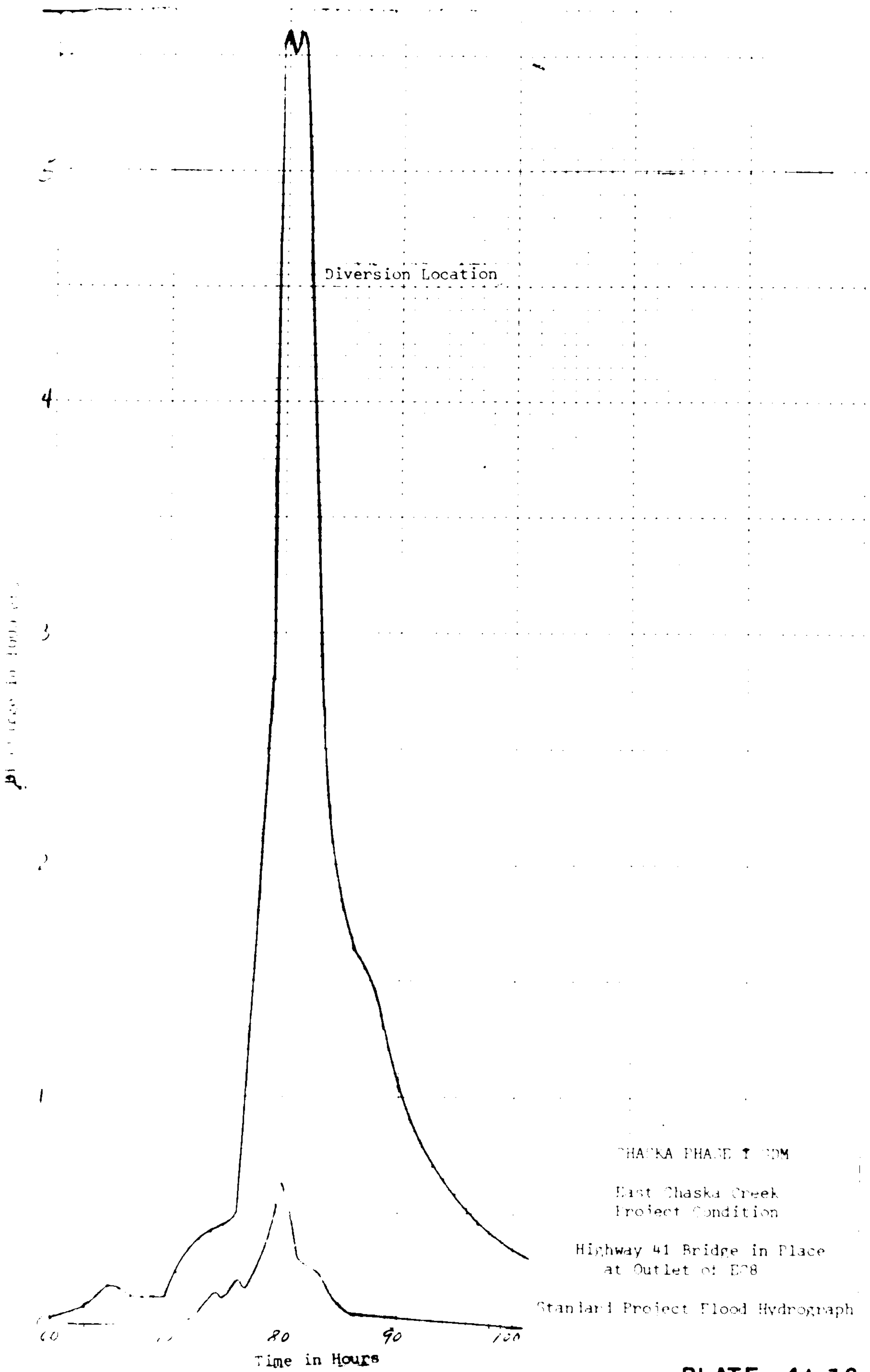
CHASKA PHASE I GDM

East Chaska Creek
Project Condition

Highway 41 Bridge in Place
at Outlet of EC8

500-yr Flood Hydrograph

PLATE 4A-37



CHASKA PHASE I GDM

East Chaska Creek
Project Condition

Highway 41 Bridge in Place
at Outlet of EC8

Standard Project Flood Hydrograph

PLATE 4A-38

APPENDIX 4B

HYDRAULIC DESIGN

APPENDIX 4B

HYDRAULIC DESIGN

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

TABLES

Number

PLATES

Number

TABLE OF CONTENTS (CONT.)

PLATES

TABLE OF CONTENTS (CONT.)

PLATES

APPENDIX 4B
HYDRAULIC DESIGN

DESCRIPTION OF PROJECT

GENERAL

The proposed project will consist of channel modification, levees, control structures, a tunnel, and erosion protection. Except for a short reach of the proposed tunnel under a portion of the city of Chanhassen, the proposed project features will be within the corporate limits of Chaska.

The approximately 1.9 miles of channel works, with 1.0 mile on East Creek and 0.9 mile on Chaska Creek, will consist of about 0.2 mile of riprap channel, 0.7 mile of grasslined channel, 0.2 mile of excavated channel, 0.5 mile of concrete channel and 0.2 mile of tunnel. Other project features will be a levee at the East Creek diversion structure and approximately 1.8 miles of levee along the Minnesota River.

DEGREE OF PROTECTION

Minnesota River - The proposed levee on the Minnesota River would provide protection against floods up to the 1-percent chance magnitude. A levee designed to provide protection against the standard project flood magnitude was considered. Further information about the formulation for level of protection is provided in the main report. Providing protection for less than the standard project flood is not catastrophic; therefore, only the proposed alternative design which provides 1-percent chance flood protection is presented in detail.

Chaska Creek and East Creek - The proposed channel modification for two creeks in Chaska will provide protection against floods up to the standard project flood in magnitude.

WITHOUT PROJECT CONDITION WATER SURFACE PROFILES

Minnesota River - Water surface profiles were computed for the Minnesota River using an HEC-2 computer model of the Lower Minnesota River developed by the U.S. Geological Survey in cooperation with the Minnesota Department of Natural Resources and the Lower Minnesota River Watershed District for the floodplain areas of the Lower Minnesota River in 1973 (reference a). Cross section locations in the vicinity of Chaska are shown on plates 4B-1 through 4B-3. A typical cross section surveyed in 1971 for the aforementioned 1973 study (reference a) is shown on plate 4B-4 and is located at the Minnesota Department of Transportation Highway 41 crossing. The flooded area outline is shown on plates 4B-48 and 4B-49.

Starting water surface elevations at the mouth of the Minnesota River were computed with concurrent frequency discharges on the Mississippi River using the HEC-2 model developed for pool 2 of the Mississippi River by the Minnesota Department of Natural Resources (reference m). Elevation-discharge rating curves for these locations on the Minnesota River near Chaska using the previously discussed assumptions are shown on plates 4B-6, 7 and 8.

Manning's "n" values and shock loss coefficients were selected by engineering judgment from extensive field inspections of the river valley and reference b. These coefficients were adjusted to calibrate the existing conditions model to the observed 1969 flood water surface profile. A list of "n" values and shock loss coefficients is provided in table 4B-1.

A table of observed highwater marks is presented in the appendix 4A. Water surface profiles for future conditions to reflect possible changes in conveyance of the river valley were developed by increasing Manning's "n" values by 10 percent and are shown on plate 4B-5.

Chaska Creek and East Creek - The HEC-2 models from the 1974 Chaska Creek Floodway Report (reference c) were updated with selected surveys taken in November 1979. Plan views with typical cross section locations are shown on plates 4B-9 and 4B-10. Typical cross sections are shown on plates 4B-11 through 4B-16. The computed water surface profiles are shown on plates 4B-17 through 4B-26. The flooded area outlines are shown on plates 4B-46 and 4B-47. No observed highwater mark data are available for Chaska Creek or East Creek.

The roughness coefficients, selected by engineering judgment from extensive field investigations and reference b, are shown on tables 4B-2, 4B-3, 4B-4, and 4B-5.

Two separate HEC-2 models for Chaska Creek were used to analyze the loss of flow from cross section 34.00 to cross section 45.08. A plan view with cross section locations for the second Chaska Creek model is shown on plate 4B-27. This reach has flow over the left bank into the city where water would pond behind the existing Minnesota River emergency levee. The results of these additional computations include:

a. A ponding area outline (plate 4B-28).
b. A storage-elevation curve (plate 4B-29).
c. A discharge versus percent topping bank (plate 4B-30).
d. A stage-frequency curve (plate 4B-31).
e. Computed water surface profiles for the second HEC-2 model (plate 4B-32).

DEPARTURES FROM THE AUTHORIZED PLAN

Chaska Creek - The proposed departures from the authorized plan are:

a. A rectangular concrete channel from stations 11+00 to 35+00 was selected for the following reasons:

(1) The channel for the authorized plan is located too close to the levee at station 12+00. For seepage and stability design, the channel alignment has been changed.

(2) There is a high steep bank combined with a narrow passage between, to the north, Highway 212 and an abandoned railroad and, to the south, the Minneapolis and St. Louis railroad in the reach from stations 19+00 to 22+00.

(3) A soil stability problem exists in the reach of station 20+00.

(4) The proposed rectangular channel will shorten the length of the three required bridges (First Street, Minneapolis and St. Louis Railroad and Hickory Street) by approximately two-thirds.

(5) The rectangular channel at station 35+00 will provide for a crossing at Hickory Street without altering the Minneapolis and St. Louis railroad tracks.

b. The Highway 212 bridge will be replaced, and a riprapped trapezoidal channel designed for subcritical flow is proposed upstream of the Highway 212 bridge. The guidelines for bend radius of curvature and drop structure channel approach alignment make it impractical to follow the authorized alignment in the vicinity of the Highway 212 bridge, particularly just downstream of Highway 212.

c. The authorized trapezoidal riprap channel bottom width was increased to 35 feet. This will eliminate channel bottom width transitions upstream and downstream of control structures.

East Creek - The proposed departures from the authorized plan are:

a. A combination of earth channel and 16-foot diameter concrete conduit to replace the authorized plan's supercritical flow riprap channel in the reach from the Minnesota River to upstream of Highway 212. This alternative would eliminate the relocation of the trailer park (stations 12+00 to 18+00). This alternative would also eliminate three bridges included in the authorized plan:

(1) Stoughten Avenue (station 17+40).

(2) Chicago and Northwestern Railroad (station 28+30).

(3) U.S. Highway 212 (station 29+40).

b. A soil stability problem exists along the alignment of the authorized plan riprap channel (station 0+00 to 18+00). This alternative would eliminate the soil stability problem.

c. A trapezoidal channel upstream of Highway 212 with a 35-foot bottom width and riprapped bends following an alignment south of the authorized alignment in this reach. This alternative alignment has several advantages over the authorized alignment including:

(1) It does not go as near a wetland.

(2) It would be shorter by approximately 800 feet.

(3) It would eliminate the steep high bank crossing the diversion channel at Highway 41.

(4) It would substantially reduce the number of residential structures to be relocated.

d. A channel bottom width of 35 feet is proposed for the trapezoidal channel upstream of Highway 212. This would eliminate channel transitions upstream and downstream of proposed drop structures.

PROJECT IMPACTS

Minnesota River - The proposed levee alignment on the Minnesota River is almost the same as the existing emergency levee. In addition, the floodplain on the Minnesota River at Chaska is nearly a mile wide. The proposed levee raise would not adversely affect the water surface profiles upstream or downstream of the proposed project.

Chaska Creek and East Creek - The downstream ends of the proposed channel works on both creeks are in the Minnesota River floodplain and the contribution to the total flood discharge on the Minnesota River is not significant. Therefore, there is a minimum impact at the downstream end.

Upstream of the proposed channel works, the proposed design water surface profiles will be matched at the control structures with the existing water surface profiles to result in a minimum impact upstream of the proposed project.

REFERENCES

a. "Flood Plain Area of the Lower Minnesota River," Water Resources Investigations 15-74, Open-File Report, U.S. Geological Survey, St. Paul, Minnesota, 1973.

b. Open-Channel Hydraulics, by Ven Te Chow.

c. Chaska and East Chaska Creek Floodway Report, Chaska, Minnesota, St. Paul District, U.S. Army Corps of Engineers, August 1974.

d. EM 1110-2-1601, Hydraulic Design of Flood Control Channels.

e. EB [illegible]-14, Improvements in Design and Construction in Civil Works.

f. ETL 1110-2-120, Additional Guidance for Riprap Channel Protection.

g. "Hydraulic Design Criteria," Waterways Experiment Station, Vicksburg, Mississippi (Volume 1 and 2).

h. NEH-11 Drop Spillways, U.S. Department of Agriculture.

i. ER 1165-2-118, Federal Participation in Covered Flood Control Channels.

j. EM 1110-2-1602, Hydraulic Design of Reservoir Outlet Works.

k. "Upper Mississippi River Comprehensive Basin Study, Volume III" prepared by US Army Engineer District, St. Louis, North Central Division, US Army Engineer Districts, St. Paul, Rock Island, Chicago and Environmental Science Service Administration for the Upper Mississippi River Comprehensive Basin Study Coordinating Committee, 1970.

l. Hydraulics of Closed Conduit Spillways, Part XVI: Elbows and Transitions for the Two Way Drop Inlet, USDA, AAT-NC-1, February 1979.

m. Part II, Flood Plain Areas and Water Surface Profiles, Upper Mississippi River, Pool 2, Minnesota Department of Natural Resources, 1972.

CHANNEL DESIGN - SELECTED PLAN

GENERAL

The hydraulic design was made witn guidance provided in EM 1110-2-1601 (reference d). Backwater computations for the selected channel design were made using the HEC-2 computer program. Only proposed designs for the selected plan are presented here. The details of the plan formulation are presented in appendix 2.

FREEBOARD

Minnesota River - A minimum of 3 feet of freeboard is provided. The freeboard allowance for the Minnesota River levee provides the same degree of protection against overtopping along the channel as required in paragraph 12 of reference d and paragraph 3-e of reference e. Additional discussion on freeboard is presented in the Levee Design section of this appendix.

Chaska Creek and East Creek - Freeboard provided for Chaska Creek and East Creek is based on criteria in paragraph 12 of reference d. An additional 0.5 foot of freeboard is provided for the bends on the proposed Chaska Creek diversion channel at approximately stations 14+00 and 19+00 from criteria in paragraph 11 of reference d.

VELOCITIES AND FROUDE NUMBERS

Minnesota River - The maximum computed channel velocity in the Minnesota River for the project design flood is less than 4 feet per second. Computed channel velocities are shown in table 4B-6.

Chaska Creek and East Creek - Maximum permissible channel velocities for design conditions were chosen from guidance on pages 11 and 36 of reference d. For Chaska Creek, the maximum design velocities are 13 feet per second for rectangular concrete channel, 6 feet per second for the riprapped trapezoidal channel, and 3 feet per second for excavated channel. For East Creek, the maximum design velocities are 4 feet per second for excavated channel and 6 feet per second for the riprapped channel. The maximum design velocity for the tunnel is 28 feet per second. The channels are designed for subcritical flow conditions except at control structures. To avoid unstable flow and excessive wave action, a maximum flow Froude number of 0.86 was used for the design discharge as recommended in reference d. Computed channel velocities for design conditions are shown in table 4B-7 and table 4B-8.

ICE AND DEBRIS

Ice problems may be visible during the rising side of the hydrograph and could produce rapidly rising stages on the Minnesota River. The water surface elevation for the 1-percent chance flood is above the low steel elevation of the Highway 41 bridge crossing the Minnesota River at Chaska. This inadequate bridge under-clearance is incorporated into the computed design water surface profile by reducing the main channel area under the Highway 41 bridge by 50 percent in the modified Minnesota River HEC-2 model. This is a conservative design and is considered reasonable with respect to the alternative of raising the bridge to provide adequate clearance or the fact that the proposed top of the levee is only about 1 foot higher than it would be if the without-plugging condition were used. This assumption will be refined in the Phase II GDM study. Ice problems are not anticipated on the two creeks (see appendix 4A). Debris has not caused a significant problem in Chaska during past floods. Freeboard is provided to insure that the level of protection would not be reduced by unaccounted factors such as ice, trash or debris.

TRANSITIONS

The proposed trapezoidal channel bottom widths for East Creek and Chaska Creek were chosen to be equal to the weir length for the drop structures. This selection eliminates the need for transitions except upstream of the proposed diversion channels at the rectangular channel and downstream of the proposed stilling basin. Detailed designs for these upstream transitions will be performed in the phase II study. The proposed design for the channel transition downstream of the stilling basin is presented in the paragraph on tunnel works in this appendix.

CHANNELS

<u>Minnesota River</u> - No modifications are proposed for the Minnesota River channel.

Chaska Creek and East Creek - Design channel sizes and types are shown in table 4B-9 and 4B-10. Design side slopes are generally 1.0 vertical on 3.0 horizontal for trapezoidal channels.

LOW FLOW CHANNELS

Chaska Creek and East Creek - Low flow channels are planned for Chaska Creek as part of the diversion channel and East Creek through the existing natural channel. The low flow channels are intended to contain the majority of the summer (May through October) flows. Channel cross sections used for the HEC-2 computed design water surface profiles for Chaska Creek do not include the low flow channel. During non-flood periods, low flows will be diverted into the existing channel at the upstream end of the proposed East Creek diversion channel by the proposed [illegible] drop structure with a low flow diversion conduit. The design of the low flow channels will be refined in the Phase II studies.

RIPRAP DESIGN

Proposed erosion protection for design conditions was developed with the guidance provided in paragraph 4 of reference f, paragraphs [illegible] and [illegible] of reference d, and paragraph 7-9 of reference b. Required [illegible] for proposed riprap of hydraulic structures is from guidance on Hydraulic Design Criteria Sheet 712-1, reference g. Sample computations are included at the end of this appendix.

DESIGN WATER SURFACE PROFILES

Minnesota River - The computed water surface profiles and flooded area outlines for the proposed design (1-percent chance) flood and standard project flood are shown on plates 4B-45 and 4B-46. The profiles were computed using the previously described HEC-2 Minnesota River model with the assumption for project conditions that the Manning's "n" values shown on table 4B-7 are increased by 10 percent to reflect adverse future

channel conditions and that the area under the bridge crossing the main channel is reduced by 50 percent for adverse conditions such as ice and debris. The starting water surface elevations were taken from the elevation-discharge rating curve (plate 4B-6) developed at the downstream end of the project.

Chaska Creek and East Creek - Computed water surface profiles for the proposed channel (standard project flood) design are shown on plates 4B-41 through 4B-44. The starting water surface elevations assume a 10-percent chance flood on the Minnesota River. To determine maximum velocities for the creeks, minimum starting water surface elevations were used. These elevations are the normal pool elevations on the Minnesota River.

LEVEE DESIGN - SELECTED PLAN

Minnesota River - The proposed levee will provide protection up to the 1-percent chance flood. The proposed top of levee profile was developed as a water surface profile computed with a modified Minnesota Department of Natural Resources lower Minnesota River HEC-2 model using the assumptions for the proposed design water surface profile. (Refer to the previous paragraph in this appendix on design water surface profiles.) The starting water surface elevation for this profile is taken at the downstream end of the project from a water surface elevation 3 feet above the proposed design water surface elevation. (Refer to the previous paragraph in this appendix on freeboard.) The discharge corresponding to this higher elevation was used. The top of levee profile computed with this method insures that levee overtopping will occur at the downstream end of the proposed project in accordance with paragraph 3-C of reference e. The top of levee profiles are shown on plate 4B-45. The levee alignment and proposed conditions flooded area outline are shown on plate 4B-50.

Chaska Creek and East Creek - Levees are proposed on the Chaska Creek diversion channel for the reach from station 35+00 to just downstream of

the abandoned railroad (station 43+00). Levees are proposed on East Creek from station 3+00 to station 8+00, from station 26+00 to station 47+00, and across the existing channel just downstream of the proposed diversion structure. The proposed alignment and top profile of the levee across the existing East Creek channel will be refined in the phase II GDM study when more detailed survey data will be available. The proposed levee alignments and profiles are shown on plates 4B-41 through 4B-44. The proposed with project conditions flooded area outlines are shown on plates 4B-10 and 4B-50.

HYDRAULIC STRUCTURES - SELECTED PLAN

GENERAL

Six drop structures are proposed for the Chaska flood control project (three on Chaska Creek and three on East Creek). The structure at the upstream end of East Creek will serve as a diversion structure. (Refer to the following paragraph on the diversion structure in this appendix.) These structures are needed to reduce the gradient of the proposed channels to maintain nonerosive design velocities. The concrete straight drop structures are designed in accordance with sheets 623 and 624 of reference g. The weir coefficient "C" was reduced for submergence based on reference h. Table 4B-11 lists drop structure characteristics. Typical drop structure alignment is shown on plate 4B-33.

DIVERSION STRUCTURE

The design for the proposed East Creek diversion structure at station 43+00 is presented in the previous paragraph on hydraulic structures. In addition, the proposed diversion structure shown on plate 4B-34 for East Creek will have a 4-foot diameter conduit for a low flow diversion under the proposed levee into the existing channel.

TUNNEL WORKS

General - The three components for the proposed East Creek tunnel works are the tunnel inlet structure, the tunnel, and the chute spillway as shown on plate 4B-35 and 4B-36. The tunnel inlet structure was designed through consultation with Mr. J. L. Grace from the U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi, and considerations from reference i. The design details of the tunnel works will be refined in the phase II GDM study.

Tunnel Inlet - The drop inlet design is a straight overfall weir with apron adapted from the St. Anthony Falls type drop structure presented on sheet 624-1 of reference g. The elbow design was developed using the equation shown below for flared entrances from paragraph 3-6-C of reference j. The design for the transition from the rectangular elbow to the circular conduit with a length of two conduit diameters was developed from guidance presented on page 2 of reference 1. The side and top flare equation for the proposed elbow is:

$$\frac{x^2}{D^2} + \frac{y^2}{(D/3)^2} = 1 \qquad \text{where } D = 16.$$

Tunnel - The proposed 16-foot diameter tunnel is 1,400 feet long with an inlet invert elevation of 702.2 and an outlet invert elevation of 698. The tunnel will be cast in place. The head loss through the tunnel was computed using the following equation:

$$H = h_{tr} + h_{inlet} + h_{exit} + h_f$$

where: h_{tr} = trash rack loss = $K_{tr}\frac{V^2}{2g}$, K_{tr} = .21 (reference, sheet 010-7)

h_{inlet} = inlet loss = $K_e\frac{V^2}{2g}$; K_e = 0.2

$h_{exit} = K_{ex}\frac{V^2}{2g}$, K_{ex}

$h_f = f\frac{L}{D}\frac{V^2}{2g}$ (reference g, sheet 224-1)

The friction loss was computed using the Darcy equation. The friction factor was determined from rough pipe curves in the Moody diagram. The "k" value of 0.005 was used. No trash rack is proposed. However, safety railing on the crest weir of the drop inlet is planned. The computed headwater elevation for the tunnel with the standard project flood is 743.8.

Chute Spillway - The proposed transition from the tunnel to the open channel is an energy dissipator (presented in chapter 5 of reference i) designed to prevent downstream channel degradation. The design includes a transition with a sidewall flare of 1 on 6 and a bottom parabolic curve to the hydraulic jump and a rectangular cross section stilling basin. The energy dissipator as shown on plate 4B-36 is 95 feet long, expands from 16 feet to 30 feet wide at the bottom, and has a drop of 6.1 feet. To determine maximum design velocities for the stilling basin, minimum starting water elevations were used.

BRIDGE MODIFICATIONS

Minnesota River - No modifications are proposed for the two bridges crossing the Minnesota River at Chaska.

Chaska Creek - Four bridges are proposed for the Chaska Creek diversion channel as shown on plates 4B-43 and 4B-44. Three of these (First Street, Chicago and Northwestern Railroad, and Hickory Street) are new bridges relocated from the existing channel. The fourth (Highway 212) will replace the existing Highway 212 bridge as previously discussed in this appendix in the paragraph titled "Departures from the Authorized Plan - Chaska Creek." These bridges are required for local and intrastate transportation.

East Creek - One bridge is proposed for the East Creek diversion channel at Minnesota Highway 41 as shown on plate 4B-42 to provide for intrastate transportation. The bridge requirements for East Creek have been reduced from four for the feasibility report to one for this report.

RESIDUAL FLOODPLAIN - SELECTED PLAN

East Creek - Sufficient tributary area is available on the existing East Creek channel downstream of the proposed diversion channel to generate minor flooding as discussed in the main report. The residual floodplain for East Creek was analyzed with the East Creek HEC-2 model (refer to the paragraph on East Creek without project water surface profiles) and the interior drainage runoff hydrographs presented in the appendix 4C. The results of this analysis are shown on plates 4B-10 and 4B-37.

FUNCTIONAL OPERATION - SELECTED PLAN

In order for the project to function properly, it will be necessary for the local sponsor to maintain it to keep the chances of plugging of the control structures to a minimum. This should include not only keeping the channel and near overbank areas clear of large debris but also insuring that areas used for flood storage are kept free of structures or features that could cause plugging of the control structures.

ALTERNATE PLANS

Alternative plans evaluated for East Creek are shown on plates 4B-38 through 4B-40. The plan formulation process is described in the main report.

CHANNEL STABILITY

The existing channels for East Creek, Chaska Creek and the Minnesota River were observed in field inspections. Chaska and East Creeks are presently stabilized with erosion protection in critical reaches by construction done by the Works Progress Administration in 1939. (For Chaska Creek, the critical reaches are the reach downstream of the Hickory Street bridge and the reach between the Hickory and the Third Street

bridges.) Field observations of the Chaska Creek and East Creek watersheds indicated that a relatively stable environment exists. Upstream of the proposed channel modification for Chaska Creek and East Chaska Creek, sediment is trapped in small lakes and ponds. Minor bank erosion is visible in the upstream watersheds, but does not appear excessive. Only minor deposition was visible on the inside of bends and at some bridges. Downstream of the Hickory Street bridge on Chaska Creek, where a trapezoidal channel with grouted riprap exists, armoring of the bed material on the right side of the channel just downstream of a mild bend was evident. In this reach the processes of both minor aggradation and degradation were evident. The sediment which was deposited is now protected from erosion by vegetation.

According to the applicable generalized curves in the "Upper Mississippi River Comprehensive Basin Study, Volume III" (reference k), the approximate sediment yield of Chaska Creek and East Creek is 90.0 tons per square mile per year. The fact that the upstream watersheds of the two creeks contain a wide variety of vegetation and small lakes, ponds, and marshes tends to indicate that sedimentation would not be a major problem. Sedimentation has had little or no effect on channel functioning in the past. The proposed channels for Chaska Creek and East Creek will have slopes with velocities sufficient for sediment bearing, but will not be subject to erosion as designed since the design channels will be stabilized with erosion protection where needed. The proposed project will not change anything significantly with respect to the Minnesota River since the proposed levee alignment on the Minnesota River floodplain is almost the same as the existing emergency levee. Therefore, the channel will remain stable as it has historically. A continuing maintenance program to remove possible minor sediment deposits for the proposed Chaska Creek and East Creek channels will ensure that the project will function as designed.

The average annual sediment yield from Chaska Creek and East Creek (with 14.9 and 11.6 square mile drainage areas, respectively) is 1,057 cubic yards. The resulting average annual estimated cost for sediment removal is $2,000 (in 1982 dollars).

WEST CHASKA CREEK DOWNSTREAM RIPRAP DESIGN

CROSS-SECTION NUMBER:	8.000
NUMBER OF SUBSECTIONS:	7
WATER SURFACE ELEVATION:	16.50
TOTAL DISCHARGE:	5500 CFS
DISCHARGE SUMMATION:	5500.0 CFS
AREA SUMMATION:	1593.45 SF
AVERAGE VELOCITY:	3.45 FPS

SPECIFIC WEIGHT OF STONE= 165 PCF

RIPRAP GRADATION
LAYER THICKNESS = 12 INCHES

PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT - LBS	
100	86	35
50	26	17
15	13	5

WRITE RESULTS OF THE ALPHA METHOD TO THE TERMINAL ?
I>YES

S7225260 OUTPUT
RUN DATE : 81/06/30. RUN TIME: 06.29.21.

=============================
-RESULTS OF THE ALPHA METHOD-
=============================

SUBSECTION NUMBER	XDIST R CR 1/2	DD R/K (CR 1/2)A	AREA C (CR 1/2)3 A	K Q (CR 3/2)A	P V
1	1.00 .49 23	3.20 .85 74	3.20 33.14 40451	.58 .83 36	6.48 .26
2	14.00 8.41 212	8.95 14.50 26624	125.30 73.27 1202165233	.58 296.57 223899	14.90 2.37
3	15.00 13.28 298	14.00 26.56 62639	210.00 81.85 5573126534	.50 697.73 831945	15.81 3.32
4	55.00 16.50 344	16.50 33.00 313034	907.50 84.92 3724649939	.50 2485.87 5165077	55.00 3.84
5	15.00 13.28 298	14.00 26.56 62639	210.00 81.85 5573126534	.50 697.73 831945	15.81 3.32
6	15.00 8.47 213	8.95 14.61 28677	134.25 73.38 1308570459	.58 319.44 243062	15.04 2.38
7	1.00 .49 23	3.20 .85 74	3.20 33.14 40451	.58 .83 36	6.48 .26

```
MEAN ENERGY SLOPE =                          .0001241 FT/FT
MEAN HYDRAULIC RADIUS =                         14.78 FT
AVERAGE SHEAR STRESS =                            .11 PSF
ENERGY CORRECTION FACTOR (ALPHA):                1.07

ALPHA NEGLECTED:
MEAN C =                                        80.61
EFFECTIVE K =                                     .61 FT
MANNING'S N =                                    .029

ALPHA CONSIDERED:
MEAN C =                                        83.53
EFFECTIVE K =                                     .49 FT
MANNING'S N =                                    .028
```

==========================
-SHEAR STRESS COMPUTATIONS-
==========================

TABULATION OF DEPTHS AND VELOCITIES IN SUBSECTIONS
FOR USE IN DETERMINING LOCAL BOUNDARY SHEAR STRESS

SUBSECTION NUMBER	LEFT DEPTH	RIGHT DEPTH	AVERAGE DEPTH	VELOCITY (FPS)
1	0.00	6.40	3.20	.26
2	6.40	11.50	8.95	2.37
3	11.50	16.50	14.00	3.32
4	16.50	16.50	16.50	3.84
5	16.50	11.50	14.00	3.32
6	11.50	6.40	8.95	2.38
7	6.40	0.00	3.20	.26

```
COMPUTATION FOR LEFT BANK ?
? YES

ENTER DEPTH AND VELOCITY FOR LEFT BANK:
? 11.5,3.5

ENTER NON UNIFORM FLOW FACTOR:
? 1.5

ENTER LEFT BANK SIDE SLOPE (H/V):
? 3,1

FOR LEFT BANK

KS =                                         .01090
LOCAL BOUNDARY SHEAR STRESS TO =               .20 PSF
K1 =                                          .871
DESIGN SHEAR STRESS T =                       2.06 PSF

DESIGN SHEAR STRESS EXCEEDS LOCAL BOUNDARY SHEAR STRESS
DEEPER LAYER THICKNESS CAN BE TRIED


COMPUTATION FOR RIGHT BANK ?
? YES

ENTER DEPTH AND VELOCITY FOR RIGHT BANK:
? 11.5,3.5

ENTER NON-UNIFORM FLOW FACTOR:
? 1.5

ENTER RIGHT BANK SIDE SLOPE (H/V):
? 3,1
```

FOR RIGHT BANK

K2 = .01090
LOCAL BOUNDARY SHEAR STRESS TO = .20 PSF
K1 = .871
DESIGN SHEAR STRESS T = 2.08 PSF

DESIGN SHEAR STRESS EXCEEDS LOCAL BOUNDARY SHEAR STRESS
LESSER LAYER THICKNESS CAN BE TRIED

ADDITIONAL SHEAR COMPUTATIONS FOR SECTION: 8.000 ?
I>NO

MORE RIPRAP COMPUTATIONS AT SECTION: 8.000 ?
I>NO

FINAL RIPRAP DESIGN:

DATE OF COMPUTATIONS: 81/06/30. AT 06.36.49. HRS

CROSS SECTION NUMBER: 8.000

SPECIFIC WEIGHT OF STONE= 165 PCF

RIPRAP GRADATION
LAYER THICKNESS = 12 INCHES

PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT - LBS	
100	86	35
50	26	17
15	13	5

```
CROSS-SECTION NUMBER:                 40.000
NUMBER OF SUBSECTIONS:                     5
WATER SURFACE ELEVATION:               11.52
TOTAL DISCHARGE:                        5500 CFS
DISCHARGE SUMMATION:                  5500.0 CFS
AREA SUMMATION:                       760.32 SF
AVERAGE VELOCITY:                       7.23 FPS
```

SPECIFIC WEIGHT OF STONE= 165 PCF

RIPRAP GRADATION
LAYER THICKNESS = 12 INCHES

PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT - LBS	
100	86	35
50	26	17
15	13	5

WRITE RESULTS OF THE ALPHA METHOD TO THE TERMINAL ?
I>YES

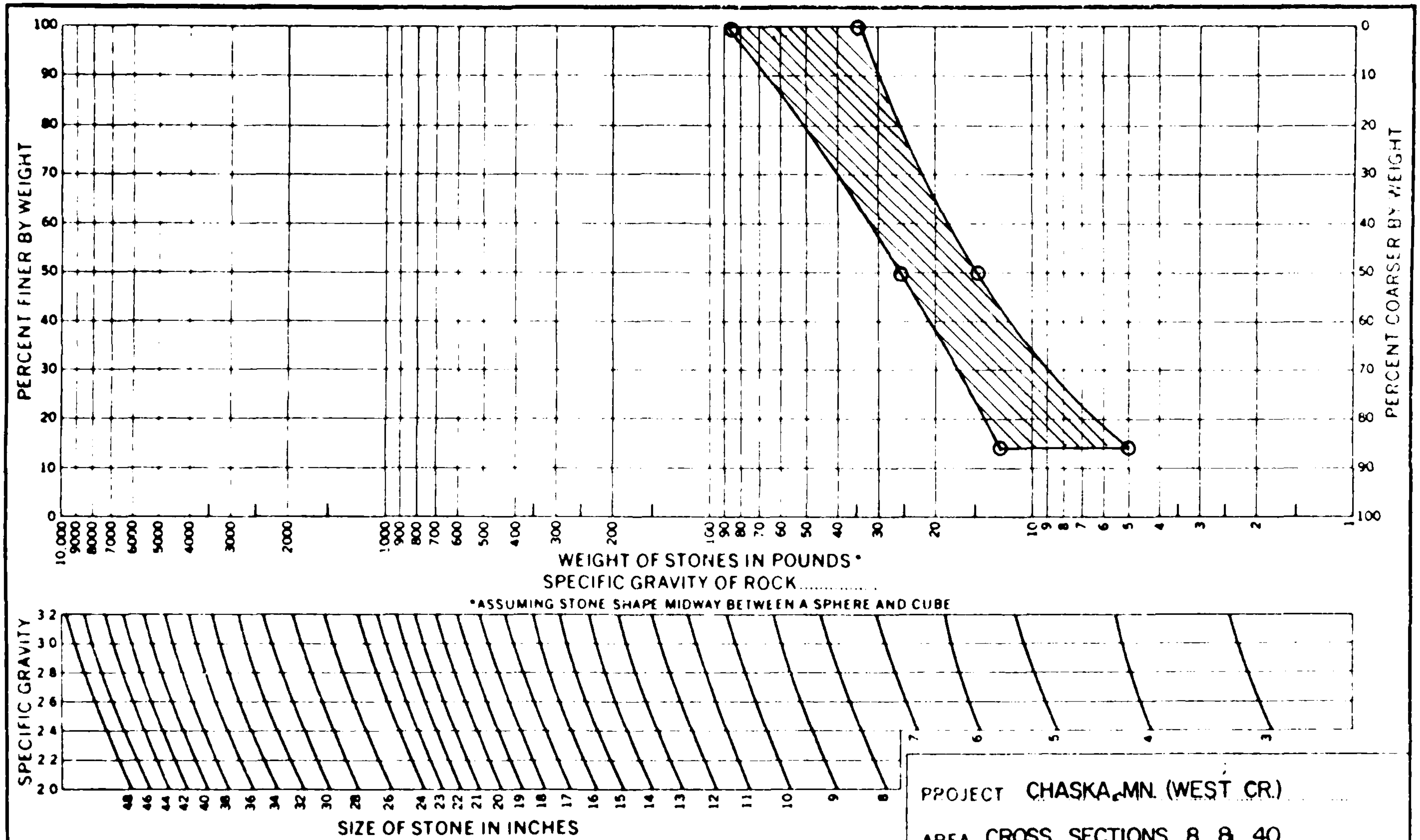
S7225260 OUTPUT
RUN DATE : 81/07/06. RUN TIME: 07.34.07.

==============================
-RESULTS OF THE ALPHA METHOD-
==============================

SUBSECTION NUMBER	XDIST R 1/2 CR	DD R/K 1/2 (CR)A	AREA C 1/2 3 (CR) A	K Q 3/2 (CR)A	P V
1	15.50 2.70 93	2.88 4.65 4194	44.64 57.19 37033495	.58 133.28 11323	16.54 2.99
2	15.50 8.10 207	8.64 13.96 27723	133.92 72.74 1188067987	.58 880.93 224526	16.54 6.58
3	35.00 11.52 270	11.52 23.04 109250	403.20 79.83 8021110521	.50 3471.56 1258570	35.00 8.61
4	15.50 8.10 207	8.64 13.96 27723	133.92 72.74 1188067987	.58 880.93 224526	16.54 6.58
5	15.50 2.70 93	2.88 4.65 4194	44.64 57.19 37033495	.58 133.28 11323	16.54 2.99

```
MEAN ENERGY SLOPE =                          .0010[illegible] FT/FT
MEAN HYDRAULIC RADIUS =                        10.00 FT
AVERAGE SHEAR STRESS =                           .63 PSF
ENERGY CORRECTION FACTOR (ALPHA):              1.17

ALPHA NEGLECTED:
MEAN C =                                       72.00
EFFECTIVE K =                                    .75 FT
MANNING S N =                                   .030

ALPHA CONSIDERED:
MEAN C =                                       77.79
EFFECTIVE K =                                    .50 FT
MANNING S N =                                   .028


                                     ==========================
                                     -SHEAR STRESS COMPUTATIONS-
                                     ==========================

BEND COMPUTATIONS:


ENTER CENTERLINE BEND RADIUS IN FEET:
I>300

ENTER FLOW FACTOR FOR BEND:
I>1.5

COMPUTATION FOR INSIDE OF BEND ?
I>YES

ENTER INSIDE BANK SIDE SLOPE (H/V):
I>2.7/1

FOR INSIDE OF BEND-

AVERAGE SHEAR STRESS=                       .63 PSF
R/W =                                      3.09
SHEAR STRESS RATIO TB/TO =                 1.27
BEND SHEAR STRESS TB =                     1.20 PSF
K1 =                                       .841
DESIGN SHEAR STRESS T =                    2.01 PSF
BEND VELOCITY =                            8.16 FPS

DESIGN SHEAR STRESS EXCEEDS BEND SHEAR STRESS
LESSER LAYER THICKNESS CAN BE TRIED


COMPUTATION FOR OUTSIDE OF BEND ?
I>YES

ENTER OUTSIDE BANK SIDE SLOPE (H/V):
I>2.7/1

FOR OUTSIDE OF BEND-

AVERAGE SHEAR STRESS=                       .63 PSF
R/W =                                      3.09
SHEAR STRESS RATIO TB/TO =                 1.76
BEND SHEAR STRESS TB =                     1.67 PSF
K1 =                                       .841
DESIGN SHEAR STRESS T =                    2.01 PSF
BEND VELOCITY =                            9.60 FPS

DESIGN SHEAR STRESS EXCEEDS BEND SHEAR STRESS
```

```
 ADDITIONAL SHEAR COMPUTATIONS FOR SECTION:     40.000 ?
I>NO

 MORE RIPRAP COMPUTATIONS AT SECTION:     40.000 ?
I>NO

                         ------------------------------------------------
                                      FINAL RIPRAP DESIGN:
                         ------------------------------------------------
                         DATE OF COMPUTATIONS:  81/07/06. AT 07.37.26. HRS
                         ------------------------------------------------

                                    CROSS SECTION NUMBER:     40.000

                                   SPECIFIC WEIGHT OF STONE= 165 PCF

                                             RIPRAP GRADATION
                                        LAYER THICKNESS = 12 INCHES

                                  PERCENT LIGHTER          LIMITS OF STONE
                                  BY WEIGHT (SSD)            WEIGHT - LBS

                                       100                   86       35
                                        50                   26       17
                                        15                   13        5


 SS225260 COMPLETE- END OF RERUN ?
I>END


 RESULTS HAVE BEEN WRITTEN TO LOCAL FILE 'TAPE8'


*END OF RIPRAP COMPUTATIONS
C>BYE
 JOB PROCESSING SSUS     15.309
BYE  81/07/06. 07.38.19.


SELECT DESIRED SERVICE:
```



PROJECT CHASKA, MN. (WEST CR.)

AREA CROSS SECTIONS 8 & 40

DATE JULY 6, 1981

RIPRAP GRADATION CURVES

ENG FORM 4055
APR 67

TABLE 4B-1
MINNESOTA RIVER
EXISTING CONDITIONS
WITHOUT PROJECT

CROSS SECTION LOCATION	ONE PERCENT CHANCE FLOOD						STANDARD PROJECT FLOOD						SHOCK LOSSES FOR SPF & 1%	
	'N' VALUES			VELOCITIES			'N' VALUES			VELOCITIES				
	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	CON.	EXP.
70	.085	.050	.070	1.19	2.80	1.33	.085	.050	.070	1.24	2.73	1.41	.1	.3
71	.085	.042	.070	1.05	3.71	1.27	.085	.042	.070	1.04	3.36	1.31	.5	.8
71.40	.085	.042	.070	1.06	3.53	1.26	.085	.042	.070	1.04	3.18	1.29	.5	.8
72.80	.085	.040	.070	1.21	3.55	.86	.085	.040	.070	1.17	3.21	.86	.5	.8
73	.085	.040	.070	1.02	3.47	.75	.085	.040	.070	1.04	3.25	.81	.1	.3
74	.085	.040	.070	.80	3.24	1.23	.085	.040	.070	.80	3.06	1.26	.1	.3
75	.085	.040	.070	0.00	2.42	1.13	.085	.040	.070	.62	2.32	1.16	.6	.8
75.40	.085	.040	.070	0.00	2.21	1.12	.085	.040	.070	.61	2.15	1.15	.6	.8
76	.085	.030	.070	.07	3.42	3.30	.085	.030	.070	1.03	1.51	2.64	.6	.8
76.20	.085	.030	.070	.07	3.41	3.30	.085	.030	.070	1.03	1.51	2.64	.6	.8
76.80	.040	.040	.060	.30	2.34	1.10	.040	.040	.060	.62	2.25	1.15	.6	.8
77	.040	.045	.060	1.47	2.43	1.19	.040	.045	.060	1.51	2.31	1.24	.1	.3
78	.085	.040	.065	.79	2.44	1.17	.085	.040	.065	.86	2.43	1.20	.1	.3

MINNESOTA RIVER
FUTURE CONDITIONS
WITHOUT PROJECT

CROSS SECTION LOCATION	ONE PERCENT CHANCE FLOOD						STANDARD PROJECT FLOOD						SHOCK LOSSES FOR 1% & SPF	
	'N' VALUES			VELOCITIES			'N' VALUES			VELOCITIES				
	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	CON.	EXP.
70	.094	.055	.077	1.14	2.70	1.27	.094	.055	.077	1.21	2.65	1.38	.1	.3
71	.094	.046	.077	1.01	3.50	1.22	.094	.046	.077	1.01	3.21	1.27	.5	.8
71.40	.094	.046	.077	1.02	3.33	1.21	.094	.046	.077	1.01	3.04	1.25	.5	.8
72.80	.094	.044	.077	1.16	3.35	.81	.094	.044	.077	1.01	3.86	.75	.5	.8
73	.094	.044	.077	.99	3.29	.73	.094	.044	.077	.88	3.81	.69	.1	.3
74	.094	.044	.077	.85	3.07	1.10	.094	.044	.077	.72	3.83	1.10	.1	.3
75	.094	.044	.077	0.00	2.29	1.08	.094	.044	.077	.58	3.06	1.02	.6	.8
75.40	.094	.044	.077	0.00	2.09	1.07	.094	.044	.077	.56	2.79	1.00	.6	.8
76	.094	.033	.077	.06	2.97	3.11	.094	.033	.077	1.02	1.41	2.51	.6	.8
76.20	.094	.033	.077	.06	2.97	3.11	.094	.033	.077	1.02	1.41	2.51	.6	.8
76.80	.044	.044	.066	.40	2.22	1.06	.044	.044	.066	.64	2.18	1.12	.6	.8
77	.044	.050	.066	1.40	2.30	1.14	.044	.050	.066	1.48	2.24	1.21	.1	.3
[illegible]	.094	.044	.072	.78	2.32	1.12	.094	.044	.072	.84	2.36	1.17	.1	.3

TABLE 4B-2
CHASKA CREEK
EXISTING CONDITIONS WITHOUT PROJECT

CROSS SECTION LOCATION	ONE PERCENT CHANCE FLOOD						STANDARD PROJECT FLOOD						SHOCK LOSSES FOR 1% & SPF	
	'N' VALUES			VELOCITIES			'N' VALUES			VELOCITIES				
	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	CON.	EXP.
1.70	.150	.040	.150	.08	.36	.08	.150	.040	.150	.07	.31	.07	.1	.3
2.30	.150	.040	.150	.12	.53	.12	.150	.040	.150	.09	.39	.09	.1	.3
10.80	.150	.040	.150	.15	.73	.16	.150	.040	.150	.12	.55	.13	.1	.3
19.15	.050	.040	.045	.39	.65	.47	.050	.040	.045	.14	.20	.15	.1	.3
24	.050	.040	.045	.45	.74	.53	.050	.040	.045	.15	.22	.16	.1	.3
27.50	.100	.040	.100	.51	1.66	.54	.100	.040	.100	.14	.42	.16	.1	.3
28.90	.100	.040	.100	.54	1.81	.58	.100	.040	.100	.15	.45	.16	.1	.3
29.60	.120	.040	.100	0.00	3.86	1.04	.120	.040	.100	.25	1.47	.47	.3	.5
30.30	.120	.040	.100	0.00	4.52	.66	.120	.040	.100	.25	1.51	.48	.3	.5
31.10	.120	.040	.100	.73	6.27	.46	.120	.040	.100	.64	2.26	.61	.5	1.0
31.11	.120	.040	.100	2.86	11.20	1.79	.120	.040	.100	.93	1.79	.88	.5	1.0
31.53	.120	.040	.100	2.13	6.39	2.20	.120	.040	.100	.93	1.79	.88	.5	1.0
31.54	.120	.040	.100	.78	4.64	.83	.120	.040	.100	.64	2.25	.61	.5	1.0
34	.120	.040	.100	.48	1.91	.51	.120	.040	.100	.36	1.28	.35	.5	1.0
40.86	.100	.035	.100	.95	3.85	.93	.100	.035	.100	.43	1.65	.41	.5	1.0
42.01	.100	.035	.100	2.41	5.20	2.38	.100	.035	.100	.86	1.68	.82	.5	1.0
43.76	.100	.035	.100	1.37	5.83	.78	.100	.035	.100	.75	2.80	.57	.5	1.0
44.42	.150	.035	.150	.84	7.11	.89	.150	.035	.150	.51	3.19	.53	.5	1.0
45.08	.100	.035	.100	1.75	9.83	1.79	.100	.035	.100	.94	3.51	.96	.5	1.0
45.09	.100	.035	.100	1.75	10.02	1.81	.100	.035	.100	.93	3.45	.94	.5	1.0
45.33	.120	.035	.120	[illegible]	11.16	1.10	.120	.035	.120	1.02	6.16	1.02	.5	1.0
47.89	.120	.035	.120	3.23	6.34	3.22	.120	.035	.120	1.61	3.37	1.66	.5	1.0
49.66	.150	.035	.150	.93	5.57	.82	.150	.035	.150	.85	5.86	.74	.5	1.0
53.16	.100	.035	.050	1.58	3.99	3.07	.100	.035	.050	1.25	3.15	2.10	.5	1.0
54.56	.100	.035	.100	1.78	8.66	1.83	.100	.035	.100	1.60	8.34	1.43	.6	.8
55.80	.100	.035	.100	1.15	5.98	1.16	.100	.035	.100	1.25	7.65	1.34	.6	.8
57.20	.100	.035	.080	1.16	5.92	1.47	.100	.035	.080	1.00	5.47	1.33	.5	1.0
58.14	.100	.035	.080	.89	7.48	1.23	.100	.035	.080	1.15	9.16	1.55	.5	1.0
59.07	.100	.035	.080	.74	7.27	0.00	.100	.035	.080	1.07	9.83	0.00	.5	1.0
59.08	.100	.035	.080	0.00	8.43	0.00	.100	.035	.080	0.00	12.00	0.00	.5	1.0
59.20	.100	.035	.080	0.00	8.43	0.00	.100	.035	.080	0.00	12.00	0.00	.5	1.0
59.21	.100	.035	.080	0.00	6.49	0.00	.100	.035	.080	.96	5.07	.41	.5	1.0
59.34	.080	.035	.080	1.22	8.16	1.27	.080	.035	.080	1.47	5.90	1.21	.5	1.0
59.52	.080	.035	.080	0.00	4.59	0.00	.080	.035	.080	.85	3.39	.87	.5	1.0
59.70	.080	.035	.080	0.00	11.47	0.00	.080	.035	.080	0.00	12.41	0.00	.5	1.0
60.20	.080	.035	.080	0.00	11.79	0.00	.080	.035	.080	0.00	12.72	0.00	.5	1.0
61	.100	.045	.100	1.46	6.77	1.96	.100	.045	.100	1.23	4.12	1.29	.5	1.0
62	.100	.045	.100	1.52	9.43	1.55	.100	.045	.100	1.32	5.09	1.25	.5	1.0
62.50	.100	.045	.100	1.56	7.40	1.62	.100	.045	.100	1.31	5.00	1.24	.5	1.0
63	.100	.045	.100	1.24	10.05	1.65	.100	.045	.100	1.88	10.77	2.29	.5	1.0
63.10	.100	.045	.100	2.54	8.23	1.92	.100	.045	.100	1.99	7.36	2.12	.5	1.0
63.20	.100	.045	.100	.97	6.27	1.08	.100	.045	.100	1.23	7.58	1.46	.5	1.0
64.70	.035	.040	.100	3.55	7.12	1.38	.035	.040	.100	3.48	8.26	1.79	.5	1.0
71	.110	.040	.110	0.00	8.89	1.72	.110	.040	.110	0.00	10.83	2.13	.1	.3
72	.035	.040	.100	0.00	11.09	2.35	.035	.040	.100	0.00	12.60	2.68	.3	.5
78.70	.110	.014	.110	0.00	15.35	0.00	.110	.014	.110	0.00	17.29	0.00	.4	.6
79	.110	.014	.110	0.00	13.46	0.00	.110	.014	.110	0.00	16.85	0.00	.4	.6
80.70	.110	.045	.110	1.27	6.14	1.65	.110	.045	.110	1.37	6.07	1.55	.3	.5
83.20	.110	.045	.110	1.63	8.56	1.93	.110	.045	.110	1.73	8.31	2.23	.3	.5
86.70	.110	.045	.110	1.90	11.24	1.95	.110	.045	.110	2.14	10.93	2.64	.3	.5
90.70	.110	.045	.100	2.88	10.76	2.62	.110	.045	.100	3.28	12.43	3.08	.3	.5

TABLE 4B-3
CHASKA CREEK
FUTURE CONDITIONS WITHOUT PROJECT

CROSS SECTION LOCATION	ONE PERCENT CHANCE FLOOD 'N' VALUES			ONE PERCENT CHANCE FLOOD VELOCITIES			STANDARD PROJECT FLOOD 'N' VALUES			STANDARD PROJECT FLOOD VELOCITIES			SHOCK LOSSES FOR 1% & SPF	
	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	CON.	EXP.
1.70	.150	.040	.150	.09	.39	.09	.150	.040	.150	.08	.36	.08	.1	.3
2.30	.150	.040	.150	.13	.57	.12	.150	.040	.150	.11	.44	.10	.1	.3
10.80	.150	.040	.150	.16	.77	.17	.150	.040	.150	.14	.63	.14	.1	.3
19.15	.050	.040	.045	.41	.69	.50	.050	.040	.045	.15	.22	.17	.1	.3
24	.050	.040	.045	.48	.78	.56	.050	.040	.045	.17	.25	.18	.1	.3
27.50	.100	.040	.100	.54	1.75	.57	.100	.040	.100	.16	.48	.18	.1	.3
28.90	.100	.040	.100	.57	1.91	.61	.100	.040	.100	.16	.50	.18	.1	.3
29.60	.120	.040	.100	0.06	4.09	1.11	.120	.040	.100	.28	1.64	.53	.3	.5
30.30	.120	.040	.100	0.00	4.79	.70	.120	.040	.100	.28	1.69	.54	.3	.5
31.10	.120	.040	.100	.82	6.62	.55	.120	.040	.100	.71	2.46	.68	.5	1.0
31.11	.120	.040	.100	3.11	11.52	2.07	.120	.040	.100	1.00	1.92	.97	.5	1.0
31.53	.120	.040	.100	2.13	6.33	2.27	.120	.040	.100	1.00	1.92	.97	.5	1.0
31.54	.120	.040	.100	.82	4.82	.89	.120	.040	.100	.70	2.44	.68	.5	1.0
34	.120	.040	.100	.50	1.98	.52	.120	.040	.100	.40	1.42	.39	.5	1.0
40.86	.100	.035	.100	.99	3.96	.97	.100	.035	.100	.47	1.80	.45	.5	1.0
42.01	.100	.035	.100	2.96	6.30	2.93	.100	.035	.100	.95	1.82	.91	.5	1.0
43.76	.100	.035	.100	1.65	6.86	.90	.100	.035	.100	.83	3.03	.64	.5	1.0
44.42	.150	.035	.150	1.03	8.20	1.10	.150	.035	.150	.56	3.43	.59	.5	1.0
45.08	.100	.035	.100	2.35	11.69	2.38	.100	.035	.100	1.02	3.64	1.02	.5	1.0
45.09	.100	.035	.100	2.36	11.94	2.41	.100	.035	.100	1.01	3.58	1.01	.5	1.0
45.33	.120	.035	.120	1.74	12.35	1.67	.120	.035	.120	1.09	6.22	1.10	.5	1.0
47.89	.120	.035	.120	3.70	7.06	3.65	.120	.035	.120	1.66	3.39	1.69	.5	1.0
49.66	.150	.035	.150	1.17	6.68	1.05	.150	.035	.150	.90	6.08	.80	.5	1.0
53.16	.100	.035	.050	1.82	3.87	3.57	.100	.035	.050	1.24	2.89	2.15	.5	1.0
54.56	.100	.035	.100	2.24	9.99	2.32	.100	.035	.100	1.71	8.44	1.53	.6	.8
55.80	.100	.035	.100	1.32	5.81	1.34	.100	.035	.100	1.33	7.40	1.42	.6	.8
57.20	.100	.035	.080	1.40	6.19	1.78	.100	.035	.080	1.10	5.68	1.46	.5	1.0
58.14	.100	.035	.080	1.32	7.01	1.65	.100	.035	.080	1.31	9.56	1.79	.5	1.0
59.07	.100	.035	.080	1.14	7.44	0.00	.100	.035	.080	1.36	10.75	0.00	.5	1.0
59.08	.100	.035	.080	0.00	12.00	0.00	.100	.035	.080	0.00	14.18	0.00	.5	1.0
59.20	.100	.035	.080	0.00	12.00	0.00	.100	.035	.080	0.00	14.18	0.00	.5	1.0
59.21	.100	.035	.080	.80	3.69	.54	.100	.035	.080	.90	4.00	.66	.5	1.0
59.34	.080	.035	.080	1.22	4.31	.97	.080	.035	.080	1.37	4.70	1.06	.5	1.0
59.52	.080	.035	.080	0.00	4.24	0.00	.080	.035	.080	.83	2.89	.84	.5	1.0
59.70	.080	.035	.080	0.00	11.39	0.00	.080	.035	.080	0.00	13.30	0.00	.5	1.0
60.20	.080	.035	.080	0.00	11.44	0.00	.080	.035	.080	0.00	13.30	0.00	.5	1.0
61	.100	.045	.100	1.58	5.50	1.72	.100	.045	.100	1.11	3.37	1.09	.5	1.0
62	.100	.045	.100	1.81	7.02	1.94	.100	.045	.100	1.09	3.58	1.01	.5	1.0
62.50	.100	.045	.100	1.81	6.90	1.95	.100	.045	.100	1.09	3.57	1.01	.5	1.0
63	.100	.045	100	1.88	10.76	2.29	.100	.045	.100	2.12	9.61	2.41	.5	1.0
63.10	.100	.045	.100	3.44	10.77	2.72	.100	.045	.100	2.18	7.39	2.31	.5	1.0
63.28	.100	.045	.100	1.42	7.69	1.49	.100	.045	.100	1.40	8.03	1.67	.5	1.0
64.70	.035	.040	.100	3.37	7.92	1.75	.035	.040	.100	3.70	8.29	1.92	.5	1.0
71	.110	.040	.110	0.00	10.00	2.14	.110	.040	.110	0.00	12.03	2.44	.1	.3
72	.035	.040	.100	0.00	12.60	2.68	.035	.040	.100	0.00	13.37	2.83	.3	.5
78.70	.110	.014	.110	0.00	17.28	0.00	.110	.014	.110	0.00	18.42	0.00	.4	.6
79	.110	.014	.110	0.00	16.76	0.00	.110	.014	.110	0.00	18.00	0.00	.4	.6
80.70	.110	.045	.110	1.37	6.09	1.56	.110	.045	.110	1.45	5.85	1.57	.3	.5
83.20	.110	.045	.110	1.73	8.32	2.24	.110	.045	.110	1.68	7.62	1.97	.3	.5
85.70	.110	.045	.110	2.15	10.95	2.65	.110	.045	.110	2.15	10.45	2.79	.3	.5
90.70	.110	.045	.100	3.28	12.41	3.07	.110	.045	.100	3.38	12.76	3.19	.3	.5

TABLE 4B-4

EAST CREEK
EXISTING CONDITIONS
WITHOUT PROJECT

CROSS SECTION LOCATION	ONE PERCENT CHANCE FLOOD						STANDARD PROJECT FLOOD						SHOCK LOSSES FOR 1% & SPF	
	'N' VALUES			VELOCITIES			'N' VALUES			VELOCITIES				
	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	CON.	EXP.
20.90	.150	.060	.150	.22	.70	.24	.150	.060	.150	.14	.46	.17	.1	.3
27.70	.150	.060	.150	.50	1.37	.33	.150	.060	.150	.22	.74	.21	.1	.3
32	.150	.060	.150	.77	2.14	.57	.150	.060	.150	.39	1.29	.38	.1	.3
37.75	.150	.060	.150	.42	2.88	.55	.150	.060	.150	.25	.92	.27	.1	.3
38.10	.150	.060	.150	.42	2.88	.56	.150	.060	.150	.25	.91	.27	.1	.3
40	.150	.060	.150	1.29	6.30	.70	.150	.060	.150	.36	1.32	.35	.1	.3
41	.150	.060	.150	1.20	4.76	.61	.150	.060	.150	.59	1.82	.48	.1	.3
41.01	.150	.060	.150	1.68	3.18	.86	.150	.060	.150	.74	1.09	.60	.1	.3
41.04	.150	.060	.150	1.68	3.18	.86	.150	.060	.150	.73	1.09	.59	.1	.3
41.05	.150	.060	.150	1.19	4.69	.61	.150	.060	.150	.59	1.82	.48	.1	.3
43.70	.150	.060	.150	1.14	5.22	.67	.150	.060	.150	.42	1.34	.35	.1	.3
47.30	.100	.050	.100	1.27	4.39	.93	.100	.050	.100	.45	1.20	.44	.3	.5
47.55	.100	.050	.100	1.13	3.64	.75	.100	.050	.100	.44	1.16	.42	.3	.5
47.60	.100	.050	.100	2.12	4.59	1.58	.100	.050	.100	.59	.60	.61	.3	.5
47.80	.100	.050	.100	2.00	4.18	1.54	.100	.050	.100	.59	.60	.61	.3	.5
47.85	.100	.050	.100	1.29	6.37	1.49	.100	.050	.100	.43	1.20	.43	.3	.5
48.75	.100	.050	.100	1.21	7.16	1.21	.100	.060	.100	.52	1.53	.52	.3	.5
50.20	.100	.050	.100	1.46	5.05	1.02	.100	.050	.100	.70	1.95	.60	.5	.7
50.25	.100	.050	.100	2.04	3.59	1.19	.100	.050	.100	.91	.99	.76	.5	.7
50.35	.100	.050	.100	2.02	3.52	1.18	.100	.050	.100	.91	.99	.76	.5	.7
50.50	.100	.050	.100	1.13	3.44	.73	.100	.050	.100	.53	1.32	.46	.5	.7
50.65	.100	.050	.100	1.12	3.42	.73	.100	.050	.100	.53	1.32	.46	.5	.7
50.75	.100	.050	.100	.80	2.23	.60	.100	.050	.100	.52	1.30	.45	.3	.5
51.50	.100	.050	.100	.91	4.07	.96	.100	.050	.100	.51	1.86	.59	.3	.5
52	.100	.050	.100	1.14	4.84	1.06	.100	.050	.100	.59	2.03	.62	.3	.5
52.25	.100	.050	.100	1.13	4.77	1.03	.100	.050	.100	.56	1.94	.59	.2	.4
56	.125	.060	.125	1.68	7.51	.90	.125	.060	.125	1.04	3.61	.69	.1	.3
62	.125	.060	.125	1.70	5.21	.80	.125	.060	.125	2.35	7.67	.98	.1	.3
66	.125	.060	.125	1.34	6.64	1.59	.125	.060	.125	1.36	6.02	1.55	.1	.3
69	.125	.060	.125	1.06	4.04	1.31	.125	.060	.125	1.13	4.19	1.39	.1	.3
73	.125	.060	.125	1.84	8.74	2.02	.125	.060	.125	2.03	9.08	2.21	.4	.6
75.50	.125	.060	.125	2.50	9.06	1.31	.125	.060	.125	2.59	9.33	1.56	.4	.6
80	.125	.060	.125	.92	3.58	.92	.125	.060	.125	.96	3.61	.96	.4	.6
83.50	.125	.060	.125	1.41	6.57	1.01	.125	.060	.125	1.46	6.49	1.11	.2	.4
84.10	.125	.060	.125	1.13	6.11	1.59	.125	.060	.125	1.18	6.08	1.65	.2	.4
84.50	.125	.060	.125	1.30	6.63	1.62	.125	.060	.125	1.40	6.65	1.69	.1	.3
90	.150	.080	.150	1.07	4.29	1.07	.150	.080	.150	1.15	4.44	1.14	.1	.3
93	.150	.080	.150	1.36	4.86	.69	.150	.080	.150	1.44	4.97	.76	.1	.3
96	.150	.080	.150	1.47	4.89	.93	.150	.080	.150	1.51	4.87	.96	.1	.3
99	.150	.080	.150	1.08	2.64	.62	.150	.080	.150	1.11	2.68	.65	.1	.3
102	.150	.080	.150	1.33	4.32	.63	.150	.080	.150	1.27	3.79	.56	.1	.3
105	.150	.080	.150	1.43	5.54	.75	.150	.080	.150	1.37	5.95	.74	.1	.3
108	.100	.070	.100	1.46	5.85	.90	.100	.070	.100	1.62	6.34	1.02	.1	.3
111	.100	.070	.100	1.61	5.32	1.59	.100	.070	.100	1.35	5.31	1.66	.1	.3
114	.100	.070	.100	.56	2.73	1.09	.100	.070	.100	.63	2.92	1.16	.1	.3
116	.100	.070	.100	.36	1.31	.64	.100	.070	.100	.40	1.38	.68	.1	.3
119.50	.080	.050	.080	1.00	4.27	1.98	.080	.050	.080	1.11	4.72	2.19	.1	.3
120.50	.080	.050	.080	1.59	4.86	1.65	.080	.050	.080	1.74	5.30	1.82	.1	.2
121.35	.080	.050	.080	2.66	7.21	2.17	.080	.050	.080	2.73	7.75	2.36	.1	.2
122.85	.080	.050	.080	2.44	9.48	0.00	.080	.050	.080	2.65	9.49	0.00	.2	.4
123.25	.080	.050	.080	8.16	8.14	0.00	.080	.050	.080	2.36	8.08	0.00	.2	.4
124.50	.080	.050	.080	2.31	10.15	2.01	.080	.050	.080	2.06	9.56	2.37	.1	.3
126.50	.080	.050	.080	.52	9.74	3.41	.080	.050	.080	.77	10.76	3.81	.1	.3
128	.080	.050	.080	3.13	10.16	1.83	.080	.050	.080	3.39	10.58	2.02	.2	.4
128.25	.080	.050	.080	2.65	7.43	1.65	.080	.050	.080	2.83	7.66	1.78	.2	.4
129.30	.080	.050	.080	.72	8.82	0.00	.080	.050	.080	1.12	9.51	.19	.1	.3

TABLE 4B-5
EAST CREEK
FUTURE CONDITIONS WITHOUT PROJECT

CROSS SECTION LOCATION	ONE PERCENT CHANCE FLOOD						STANDARD PROJECT FLOOD						SHOCK LOSSES FOR 1% & SPF	
	'N' VALUES			VELOCITIES			'N' VALUES			VELOCITIES				
	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	CON.	EXP.
20.90	.150	.060	.150	.23	.74	.26	.150	.060	.150	.15	.48	.17	.1	.3
27.70	.150	.060	.150	.50	1.41	.35	.150	.060	.150	.22	.75	.22	.1	.3
32	.150	.060	.150	.80	2.22	.61	.150	.060	.150	.39	1.32	.39	.1	.3
37.75	.150	.060	.150	.44	2.55	.55	.150	.060	.150	.25	.93	.28	.1	.3
38.10	.150	.060	.150	.45	2.54	.56	.150	.060	.150	.25	.92	.28	.1	.3
40	.150	.060	.150	1.21	5.31	.76	.150	.060	.150	.36	1.30	.35	.1	.3
41	.150	.060	.150	1.21	4.53	.70	.150	.060	.150	.61	1.84	.50	.1	.3
41.01	.150	.060	.150	1.65	2.96	.97	.150	.060	.150	.75	1.09	.61	.1	.3
41.04	.150	.060	.150	1.65	2.95	.97	.150	.060	.150	.75	1.09	.61	.1	.3
41.05	.150	.060	.150	1.20	4.48	.70	.150	.060	.150	.61	1.83	.50	.1	.3
43.70	.150	.060	.150	1.13	4.77	.71	.150	.060	.150	.41	1.32	.35	.1	.3
47.30	.100	.050	.100	1.26	4.20	1.00	.100	.050	.100	.45	1.17	.44	.3	.5
47.55	.100	.050	.100	1.14	3.59	.82	.100	.050	.100	.44	1.13	.42	.3	.5
47.60	.100	.050	.100	2.00	4.10	1.66	.100	.050	.100	.57	.58	.60	.3	.5
47.80	.100	.050	.100	1.99	3.82	1.62	.100	.050	.100	.57	.58	.60	.3	.5
47.85	.100	.050	.100	1.29	5.62	1.45	.100	.050	.100	.42	1.15	.42	.3	.5
48.75	.100	.050	.100	1.30	6.81	1.30	.100	.050	.100	.51	1.46	.51	.3	.5
50.20	.100	.050	.100	1.60	5.47	1.12	.100	.050	.100	.68	1.86	.60	.5	.7
50.25	.100	.050	.100	2.21	3.77	1.31	.100	.050	.100	.88	.90	.75	.5	.7
50.35	.100	.050	.100	2.18	3.70	1.30	.100	.050	.100	.88	.90	.75	.5	.7
50.50	.100	.050	.100	1.21	3.65	.81	.100	.050	.100	.51	1.25	.45	.5	.7
50.65	.100	.050	.100	1.21	3.62	.80	.100	.050	.100	.51	1.25	.45	.5	.7
50.75	.100	.050	.100	.86	2.39	.66	.100	.050	.100	.51	1.23	.45	.3	.5
51.50	.100	.050	.100	.99	4.24	1.03	.100	.050	.100	.48	1.68	.56	.3	.5
52	.100	.050	.100	1.22	4.99	1.13	.100	.050	.100	.54	1.81	.58	.3	.5
52.25	.100	.050	.100	1.21	4.91	1.09	.100	.050	.100	.52	1.73	.56	.2	.4
56	.125	.060	.125	1.80	7.61	.81	.125	.060	.125	.92	3.04	.67	.1	.3
62	.125	.060	.125	1.80	5.43	.92	.125	.060	.125	2.48	8.01	1.05	.1	.3
66	.125	.060	.125	1.44	6.66	1.66	.125	.060	.125	1.41	6.04	1.58	.1	.3
69	.125	.060	.125	1.14	4.20	1.39	.125	.060	.125	1.18	4.27	1.43	.1	.3
73	.125	.060	.125	2.04	9.09	2.22	.125	.060	.125	2.15	9.30	2.33	.4	.6
75.50	.125	.060	.125	2.59	9.34	1.57	.125	.060	.125	2.65	9.49	1.71	.4	.6
80	.125	.060	.125	.96	3.61	.96	.125	.060	.125	.99	3.63	.99	.4	.6
83.50	.125	.060	.125	1.46	6.49	1.12	.125	.060	.125	1.48	6.39	1.17	.2	.4
84.10	.125	.060	.125	1.19	6.07	1.65	.125	.060	.125	1.22	6.08	1.69	.2	.4
84.50	.125	.060	.125	1.40	6.65	1.69	.125	.060	.125	1.46	6.68	1.73	.1	.3
90	.150	.080	.150	1.16	4.44	1.14	.150	.080	.150	1.20	4.52	1.19	.1	.3
93	.150	.080	.150	1.44	4.98	.76	.150	.080	.150	1.50	5.06	.80	.1	.3
96	.150	.080	.150	1.56	4.99	.99	.150	.080	.150	1.56	4.92	1.01	.1	.3
99	.150	.080	.150	1.14	2.76	.68	.150	.080	.150	1.15	2.76	.69	.1	.3
102	.150	.080	.150	1.39	4.38	.69	.150	.080	.150	1.31	3.83	.59	.1	.3
105	.150	.080	.150	1.54	5.71	.82	.150	.080	.150	1.43	5.99	.78	.1	.3
108	.100	.070	.100	1.60	6.11	1.02	.100	.070	.100	1.71	6.53	1.10	.1	.3
111	.100	.070	.100	1.80	5.61	1.77	.100	.070	.100	1.42	5.42	1.75	.1	.3
114	.100	.070	.100	.65	2.92	1.18	.100	.070	.100	.69	3.00	1.20	.1	.3
116	.100	.070	.100	.41	1.46	.72	.100	.070	.100	.43	1.47	.73	.1	.3
119.50	.080	.050	.080	1.11	4.71	2.19	.080	.050	.080	1.19	5.00	2.32	.1	.3
120.50	.080	.050	.080	1.73	5.29	1.82	.080	.050	.080	1.82	5.57	1.92	.1	.2
121.35	.080	.050	.080	2.70	7.73	2.35	.080	.050	.080	2.75	8.04	2.46	.1	.2
122.85	.080	.050	.080	2.65	9.48	0.00	.080	.050	.080	2.88	10.46	0.00	.2	.4
123.25	.080	.050	.080	2.37	8.07	0.00	.080	.050	.080	2.53	8.53	0.00	.2	.4
124.50	.080	.050	.080	2.07	9.57	2.39	.080	.050	.080	2.18	9.80	2.55	.1	.3
126.50	.080	.050	.080	.79	10.80	3.82	.080	.050	.080	1.03	11.25	4.04	.1	.3
128	.080	.050	.080	3.39	10.52	2.03	.080	.050	.080	3.32	9.55	2.05	.2	.4
128.85	.080	.050	.080	2.84	7.64	1.79	.080	.050	.080	2.88	7.48	1.83	.2	.4
30	.080	.050	.080	1.14	9.53	.24	.080	.050	.080	1.44	9.78	.72	.1	[illegible]

TABLE 4B-6

MINNESOTA RIVER
PROPOSED CONDITIONS

CROSS SECTION LOCATION	ONE PERCENT CHANCE FLOOD						STANDARD PROJECT FLOOD						SHOCK LOSSES FOR 1% & SPF	
	"N" VALUES			VELOCITIES			"N" VALUES			VELOCITIES				
SECNO	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	CON.	EXP
70	.094	.055	.077	1.14	2.70	1.27	.094	.055	.077	1.21	2.65	1.38	.1	.3
71	.094	.046	.077	1.01	3.50	1.22	.094	.046	.077	1.01	3.21	1.27	.5	.8
71.40	.094	.046	.077	1.02	3.33	1.21	.094	.046	.077	1.01	3.04	1.25	.5	.8
72.80	.094	.044	.077	1.16	3.35	.81	.094	.044	.077	1.01	3.86	.75	.5	.8
73	.094	.044	.077	.99	3.29	.73	.094	.044	.077	.88	3.81	.69	.1	.3
74	.094	.044	.077	.85	3.07	1.18	.094	.044	.077	.72	3.83	1.10	.1	.3
75	.094	.044	.077	0.00	2.29	1.08	.094	.044	.077	.58	3.06	1.02	.6	.8
75.40	.094	.044	.077	0.00	2.09	1.07	.094	.044	.077	.56	2.79	1.00	.6	.8
76	.094	.033	.077	0.00	2.90	3.85	.094	.033	.077	1.09	1.25	2.68	.6	.8
76.20	.094	.033	.077	0.00	2.90	3.85	.094	.033	.077	1.09	1.25	2.68	.6	.8
76.80	.044	.044	.066	.40	2.20	1.05	.044	.044	.066	.64	2.17	1.12	.6	.8
77	.044	.050	.066	1.39	2.28	1.13	.044	.050	.066	1.48	2.24	1.21	.1	.3
78	.094	.044	.072	.76	2.30	1.11	.094	.044	.072	.84	2.36	1.17	.1	.3

TABLE 4B-7

CHASKA CREEK DIVERSION

PROPOSED CONDITIONS

CROSS SECTION LOCATION	ONE PERCENT CHANCE FLOOD						STANDARD PROJECT FLOOD						SHOCK LOSSES FOR SPF & 1%	
	'N' VALUES			VELOCITIES			'N' VALUES			VELOCITIES				
	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	CON.	EXP.
1.70	.150	.040	.150	2.41	13.55	2.64	.150	.040	.150	.27	1.23	.28	.1	.3
2.30	.150	.040	.150	2.46	15.74	1.90	.150	.040	.150	.50	2.58	.45	.1	.3
10.80	.150	.040	.150	.82	6.89	1.22	.150	.040	.150	.55	3.19	.66	.1	.3
1	.035	.035	.035	0.00	2.43	0.00	.035	.035	.035	0.00	1.49	0.00	.3	.5
2	.035	.035	.035	0.00	2.42	0.00	.035	.035	.035	0.00	1.49	0.00	.3	.5
4	.035	.035	.035	0.00	2.98	0.00	.035	.035	.035	0.00	1.81	0.00	.3	.5
6	.035	.035	.035	0.00	3.97	0.00	.035	.035	.035	0.00	2.34	0.00	.3	.5
8	.035	.035	.035	0.00	5.77	0.00	.035	.035	.035	0.00	3.48	0.00	.3	.5
10	.035	.035	.035	0.00	6.91	0.00	.035	.035	.035	0.00	4.61	0.00	.3	.5
11	.035	.035	.035	0.00	16.30	0.00	.035	.035	.035	0.00	9.95	0.00	.3	.5
11.49	.035	.035	.035	0.00	13.18	0.00	.035	.035	.035	0.00	9.83	0.00	.3	.5
11.50	.014	.014	.014	0.00	12.15	0.00	.014	.014	.014	0.00	11.08	0.00	.5	1.0
11.80	.014	.014	.014	0.00	12.17	0.00	.014	.014	.014	0.00	11.10	0.00	.1	.3
12	.014	.014	.014	0.00	12.18	0.00	.014	.014	.014	0.00	11.11	0.00	.1	.3
13	.014	.014	.014	0.00	12.23	0.00	.014	.014	.014	0.00	11.16	0.00	.1	.3
14	.014	.014	.014	0.00	12.28	0.00	.014	.014	.014	0.00	11.22	0.00	.1	.3
16	.014	.014	.014	0.00	12.40	0.00	.014	.014	.014	0.00	11.36	0.00	.1	.3
2000	.014	.014	.014	0.00	12.60	0.00	.014	.014	.014	0.00	11.60	0.00	.1	.3
24	.014	.014	.014	0.00	12.79	0.00	.014	.014	.014	0.00	11.84	0.00	.1	.3
28	.014	.014	.014	0.00	12.97	0.00	.014	.014	.014	0.00	12.07	0.00	.1	.3
32	.014	.014	.014	0.00	13.13	0.00	.014	.014	.014	0.00	12.29	0.00	.1	.3
34.60	.014	.014	.014	0.00	13.21	0.00	.014	.014	.014	0.00	12.43	0.00	.1	.3
35	.014	.014	.014	0.00	13.13	0.00	.014	.014	.014	0.00	12.37	0.00	.1	.3
35.01	.100	.040	.100	0.00	13.39	0.00	.100	.040	.100	0.00	13.31	0.00	.5	1.0
36	.100	.040	.100	0.00	8.26	0.00	.100	.040	.100	0.00	8.29	0.00	.5	1.0
37	.100	.040	.100	0.00	7.88	0.00	.100	.040	.100	0.00	7.90	0.00	.5	1.0
38	.100	.040	.100	0.00	7.63	0.00	.100	.040	.100	0.00	7.65	0.00	.5	1.0
39	.100	.040	.100	0.00	7.43	0.00	.100	.040	.100	0.00	7.44	0.00	.5	1.0
40	.100	.040	.100	0.00	7.29	0.00	.100	.040	.100	0.00	7.30	0.00	.1	.3
4200	.100	.040	.100	0.00	7.05	0.00	.100	.040	.100	0.00	7.06	0.00	.1	.3
4600	.100	.040	.100	0.00	6.71	0.00	.100	.040	.100	0.00	6.71	0.00	.5	1.0
47.50	.100	.040	.100	0.00	6.62	0.00	.100	.040	.100	0.00	6.63	0.00	.5	1.0
47.51	.100	.040	.100	0.00	12.90	0.00	.100	.040	.100	0.00	12.91	0.00	.5	1.0
48	.109	.040	.100	0.00	12.02	0.00	.100	.040	.100	0.00	12.02	0.00	.5	1.0
48.01	.100	.040	.100	0.00	17.28	0.00	.100	.040	.100	0.00	17.28	0.00	.5	1.0
49	.110	.040	.110	0.00	5.15	0.00	.110	.040	.110	0.00	5.15	0.00	.1	.3
71	.110	.040	.110	.21	9.81	2.20	.110	.040	.110	.21	9.81	2.21	.1	.3

TABLE 4B-8
EAST CREEK DIVERSION
PROPOSED CONDITIONS

CROSS SECTION LOCATION	ONE PERCENT CHANCE FLOOD						STANDARD PROJECT FLOOD						SHOCK LOSSES FOR SPF & 1%	
	"N" VALUES			VELOCITIES			"N" VALUES			VELOCITIES				
	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	LEFT	CHAN	RIGHT	CON.	EXP.
26.60	.035	.035	.035	0.00	12.20	0.00	.035	.035	.035	0.00	16.55	0.00	.5	1.0
26.90	.035	.035	.035	0.00	8.84	0.00	.035	.035	.035	0.00	9.52	0.00	.5	1.0
27.50	.035	.035	.035	0.00	6.73	0.00	.035	.035	.035	0.00	7.25	0.00	.5	1.0
29	.035	.035	.035	0.00	5.06	0.00	.035	.035	.035	0.00	5.24	0.00	.5	1.0
30	.035	.035	.035	0.00	4.77	0.00	.035	.035	.035	0.00	4.61	0.00	.5	1.0
32	.035	.035	.035	0.00	4.83	0.00	.035	.035	.035	0.00	4.67	0.00	.3	.5
34	.035	.035	.035	0.00	4.88	0.00	.035	.035	.035	0.00	4.74	0.00	.3	.5
35.50	.035	.035	.035	0.00	4.93	0.00	.035	.035	.035	0.00	4.80	0.00	.3	.5
35.51	.013	.013	.013	0.00	9.17	0.00	.013	.013	.013	0.00	9.98	0.00	.5	1.0
36	.013	.013	.013	0.00	9.14	0.00	.013	.013	.013	0.00	9.96	0.00	.5	1.0
36.01	.035	.035	.035	0.00	14.94	0.00	.035	.035	.035	0.00	16.58	0.00	.5	1.0
36.30	.035	.035	.035	0.00	8.57	0.00	.035	.035	.035	0.00	9.52	0.00	.5	1.0
36.90	.035	.035	.035	0.00	6.58	0.00	.035	.035	.035	0.00	7.25	0.00	.5	1.0
38.40	.035	.035	.035	0.00	4.94	0.00	.035	.035	.035	0.00	5.24	0.00	.5	1.0
40	.035	.035	.035	0.00	4.84	0.00	.035	.035	.035	0.00	4.78	0.00	.5	1.0
42	.035	.035	.035	0.00	4.89	0.00	.035	.035	.035	0.00	4.85	0.00	.3	.5
44	.035	.035	.035	0.00	4.94	0.00	.035	.035	.035	0.00	4.91	0.00	.3	.5
46	.035	.035	.035	0.00	4.99	0.00	.035	.035	.035	0.00	4.98	0.00	.3	.5
48.60	.035	.035	.035	0.00	5.05	0.00	.035	.035	.035	0.00	5.06	0.00	.3	.5
48.61	.013	.013	.013	0.00	9.13	0.00	.013	.013	.013	0.00	10.14	0.00	.5	1.0
49	.013	.013	.013	0.00	9.11	0.00	.013	.013	.013	0.00	10.12	0.00	.5	1.0
49.01	.013	.013	.013	0.00	14.94	0.00	.013	.013	.013	0.00	16.58	0.00	.5	1.0

TABLE 4B-9

Proposed channel characteristics [illegible]

Station	Bottom elevation (msl) [illegible]	Bottom width (feet)	Side slopes	Channel protection	Notes
[illegible]	[illegible]	[illegible]	1V:3H	Riprapped [illegible]	Trapazoidal
[illegible]	[illegible]	40	1V:3H	Riprapped [illegible]	Trapazoidal
[illegible]	[illegible]	40			Drop structure
[illegible]	[illegible]	[illegible]			Transitional
[illegible]	[illegible]	40	1V:3H	Riprapped [illegible]	Transitional
[illegible]	[illegible]	40	1V:3H	Riprapped [illegible]	Transitional
[illegible]	[illegible]	40	1V:3H	Riprapped [illegible]	Transitional
[illegible]	[illegible]	40			[illegible] spillway
[illegible]	[illegible]			Concrete	Circular conduit
[illegible]	698.6			Concrete	Circular conduit
[illegible]	[illegible]			Concrete	Circular conduit
15+[illegible]	[illegible]			Concrete	Circular conduit
[illegible]	[illegible]			Concrete	Circular conduit
[illegible]	[illegible]			Concrete	Circular conduit
[illegible]	[illegible]			Concrete	Circular conduit
[illegible]	[illegible]			Concrete	Circular conduit
[illegible]	744.0	30			Drop structure
[illegible]	744.0	30			Transitional
[illegible]	[illegible]	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	[illegible]	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	[illegible]	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	[illegible]	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	[illegible]	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	[illegible]	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	[illegible]	30			Transition
[illegible]	745.2	30			Drop structure
[illegible]	757.0	30			Transition
[illegible]	757.0	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	757.1	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	[illegible]	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	[illegible]	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	757.8	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	[illegible]	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	758.3	30	1V:3H	Grass Lined*	Trapazoidal
[illegible]	758.6	30			Drop structure
[illegible]	758.6	30	Vertical	Concrete	Rectangular
[illegible]	758.6	30	Vertical	Concrete	Rectangular
[illegible]	[illegible]	30	Vertical	Concrete	Rectangular

*Riprapped at bends and upstream and downstream [illegible] structures.

TABLE 4B-9

TABLE 4B-10

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Grass lined	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Grass lined	
[illegible]	[illegible]	[illegible]	[illegible]	Grass lined	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Riprapped (sides and bottom)	
[illegible]	[illegible]		[illegible]	Riprapped (sides and bottom)	
[illegible]	[illegible]		[illegible]	Riprapped (sides and bottom)	
[illegible]	[illegible]		Vertical	Concrete (sides and bottom)	[illegible]
[illegible]	[illegible]		Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	[illegible]
[illegible]			Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	[illegible]	Riprapped (sides and bottom)	[illegible] structure
[illegible]	[illegible]	[illegible]	[illegible]	Riprapped (sides and bottom)	Trapezoidal
[illegible]	[illegible]	[illegible]	[illegible]	Riprapped (sides and bottom)	
[illegible]	[illegible]	[illegible]	[illegible]	Riprapped (sides and bottom)	
[illegible]	[illegible]	[illegible]	[illegible]	Riprapped (sides and bottom)	
[illegible]	[illegible]	[illegible]	[illegible]	Riprapped (sides and bottom)	
[illegible]	[illegible]	[illegible]	[illegible]	Riprapped (sides and bottom)	
[illegible]	[illegible]	[illegible]	[illegible]	Riprapped (sides and bottom)	
[illegible]	[illegible]	[illegible]	[illegible]	Riprapped (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	Rectangular
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	
[illegible]	[illegible]	[illegible]	Vertical	Concrete (sides and bottom)	[illegible] structure
[illegible]	[illegible]	[illegible]	[illegible]	Riprapped (sides and bottom)	
[illegible]	[illegible]		Natural	Channel	

TABLE 4B-10

TABLE 4B-11

EAST CREEK

DROP STRUCTURE DIMENSIONS
(SEE FIGURE 1)

Location	A	B	C	D	E	F	G
3+00	14.0	20.2	53.8	18.2	19.0	-	6.8
26+60	15.0	41.8	-	-	-	-	-
48+60	13.0	10.5	44.0	14.0	19.5	2.5	-

Location	H	I	J	K	a_c
3+00	40.0	-	3.4	-	8.37
26+60	30.0	-	-	-	8.37
48+60	[illegible]	-	-	-	8.37

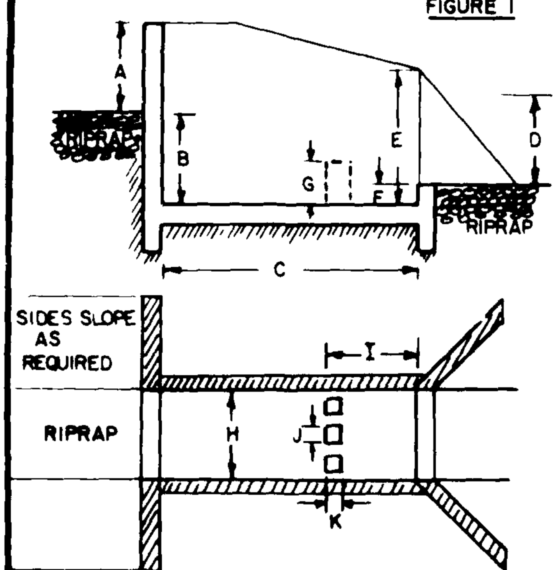
CHASKA CREEK

DROP STRUCTURE DIMENSIONS
(SEE FIGURE 1)

Location	A	B	C	D	E	F
11+50	17.0	6.35	59.0	16.5	24.0	2.0
35+00	12.0	12.4	43.0	12.8	18.4	3.0
48+00	15.0	21.6	55.0	14.0	21.2	4.0

Location	H	a_c
11+50	35.0	9.21
35+00	35.0	9.21
48+00	35.0	9.21

FIGURE 1



NOT TO SCALE

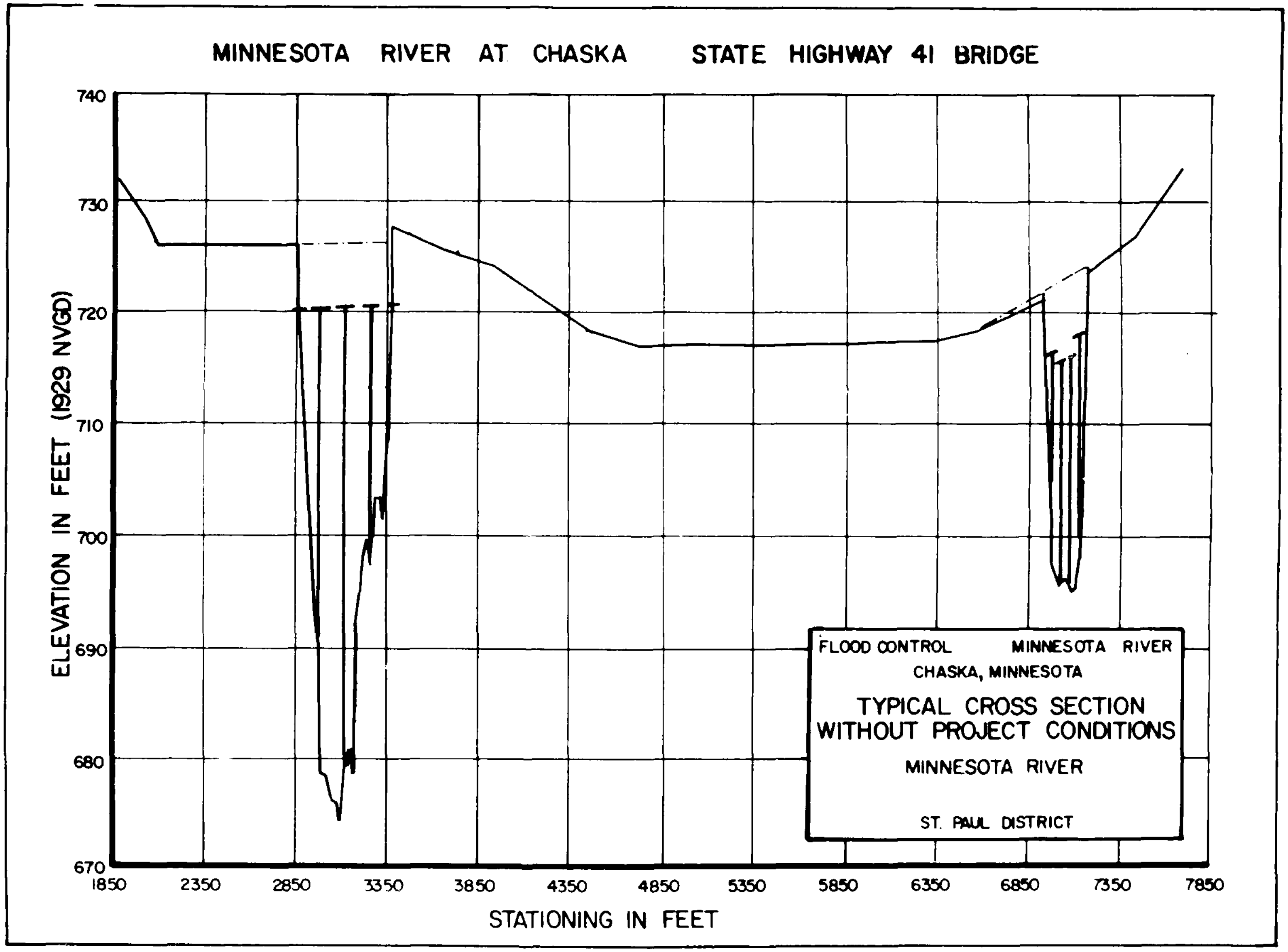
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

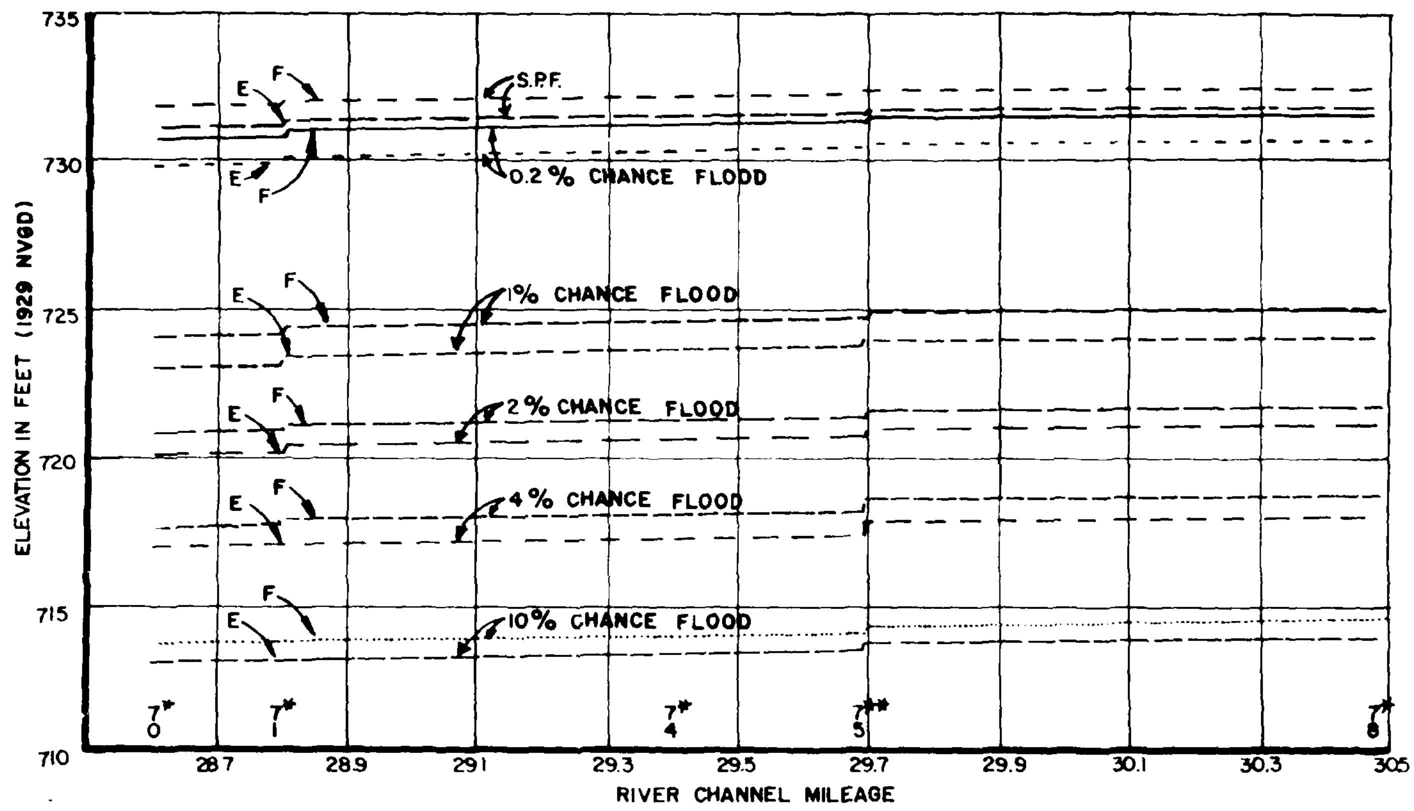
PHASE I GENERAL DESIGN MEMORANDUM

PROPOSED DROP STRUCTURE DIMENSIONS

EAST AND CHASKA CREEKS

ST. PAUL DISTRICT


MINNESOTA RIVER AT CHASKA STATE HIGHWAY 41 BRIDGE
ELEVATION IN FEET (1929 NVGD)
740
730
720
710
700
690
680
670
1850
2350
2850
3350
3850
4350
4850
5350
5850
6350
6850
7350
7850
STATIONING IN FEET
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
TYPICAL CROSS SECTION
WITHOUT PROJECT CONDITIONS
MINNESOTA RIVER
ST. PAUL DISTRICT



LEGEND

E - EXISTING CONDITIONS
F - FUTURE CONDITIONS
* - DENOTES CROSS SECTION LOCATIONS
** - HIGHWAY 41 BRIDGE CROSSING

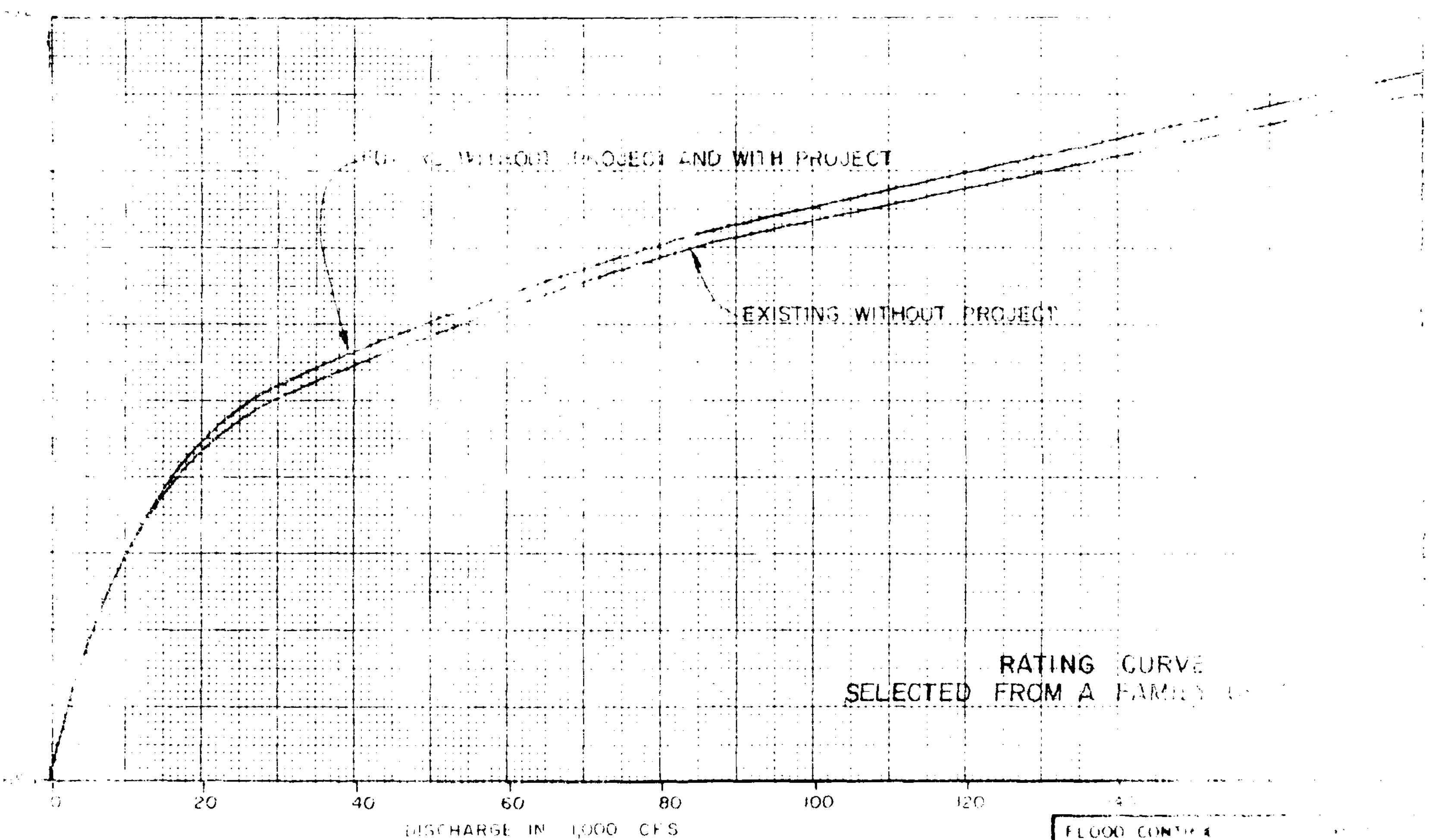
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

MINNESOTA RIVER WITHOUT PROJECT CONDITIONS

EXISTING & FUTURE CONDITIONS

10, 4, 2, 1, & 0.2 % CHANCE AND STANDARD PROJECT FLOODS

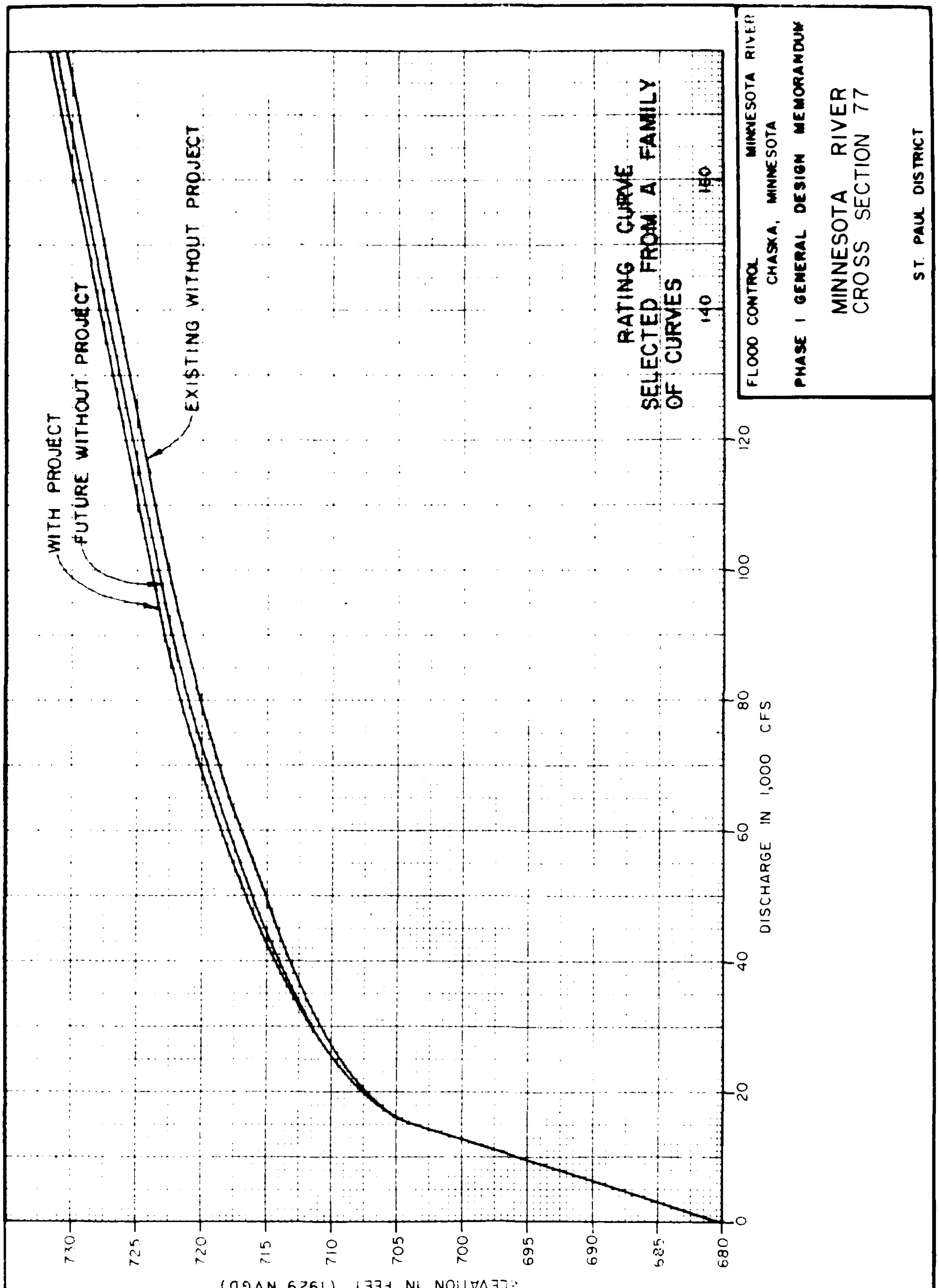
ST PAUL DISTRICT

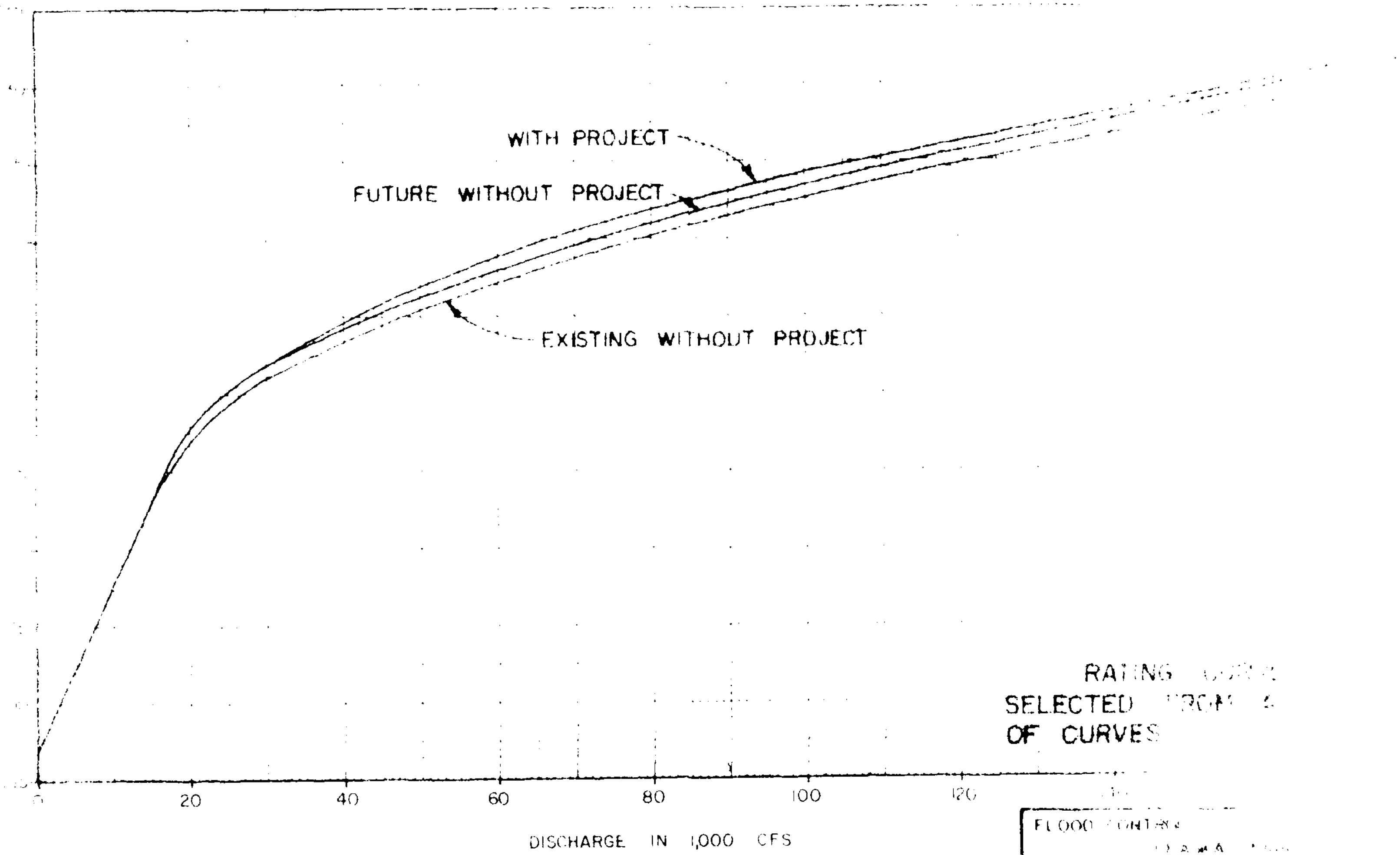


RATING CURVE
SELECTED FROM A FAMILY

FLOOD CONTROL

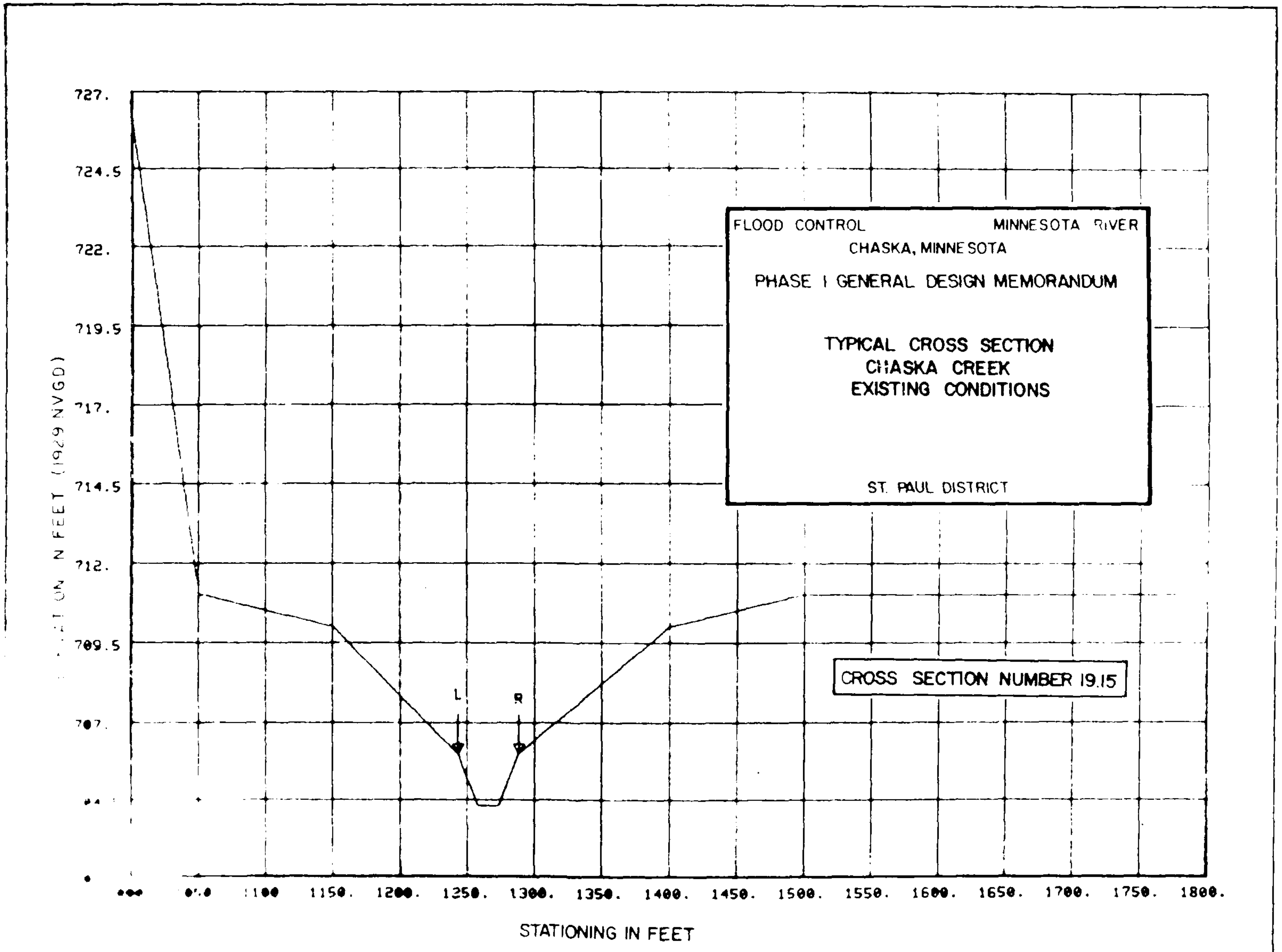
PHASE I GENERAL


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
MINNESOTA RIVER
CROSS SECTION 77
ST. PAUL DISTRICT
RATING CURVE
SELECTED FROM A FAMILY
OF CURVES
WITH PROJECT
FUTURE WITHOUT PROJECT
EXISTING WITHOUT PROJECT
ELEVATION IN FEET (1929 NVGD)
DISCHARGE IN 1,000 CFS
680
685
690
695
700
705
710
715
720
725
730
0
20
40
60
80
100
120
140
160



RATING
SELECTED
OF CURVES

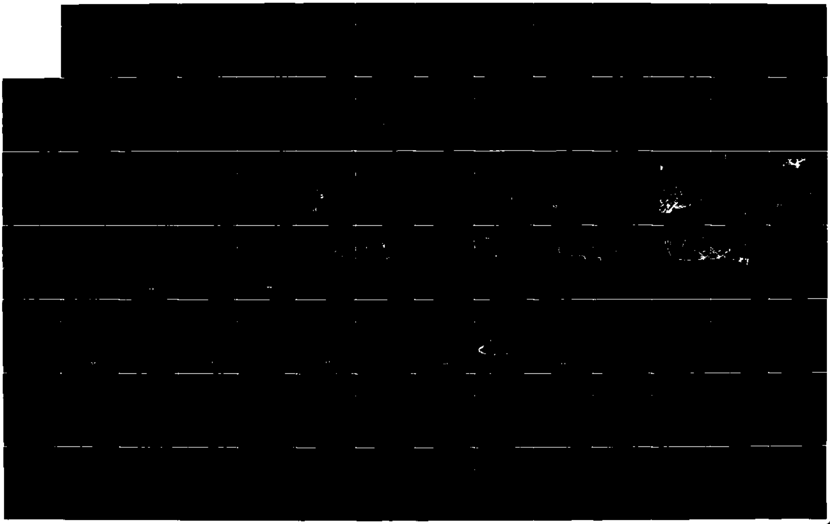
FLOOD
PHASE

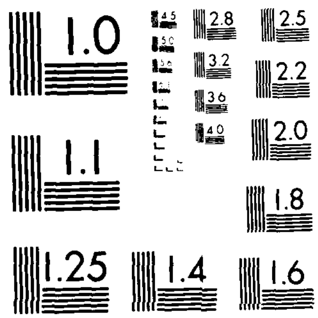


FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
TYPICAL CROSS SECTION
CHASKA CREEK
EXISTING CONDITIONS
ST. PAUL DISTRICT
CROSS SECTION NUMBER 19.15
L
R
727.
724.5
722.
719.5
717.
714.5
712.
709.5
707.
1150.
1200.
1250.
1300.
1350.
1400.
1450.
1500.
1550.
1600.
1650.
1700.
1750.
1800.
STATIONING IN FEET

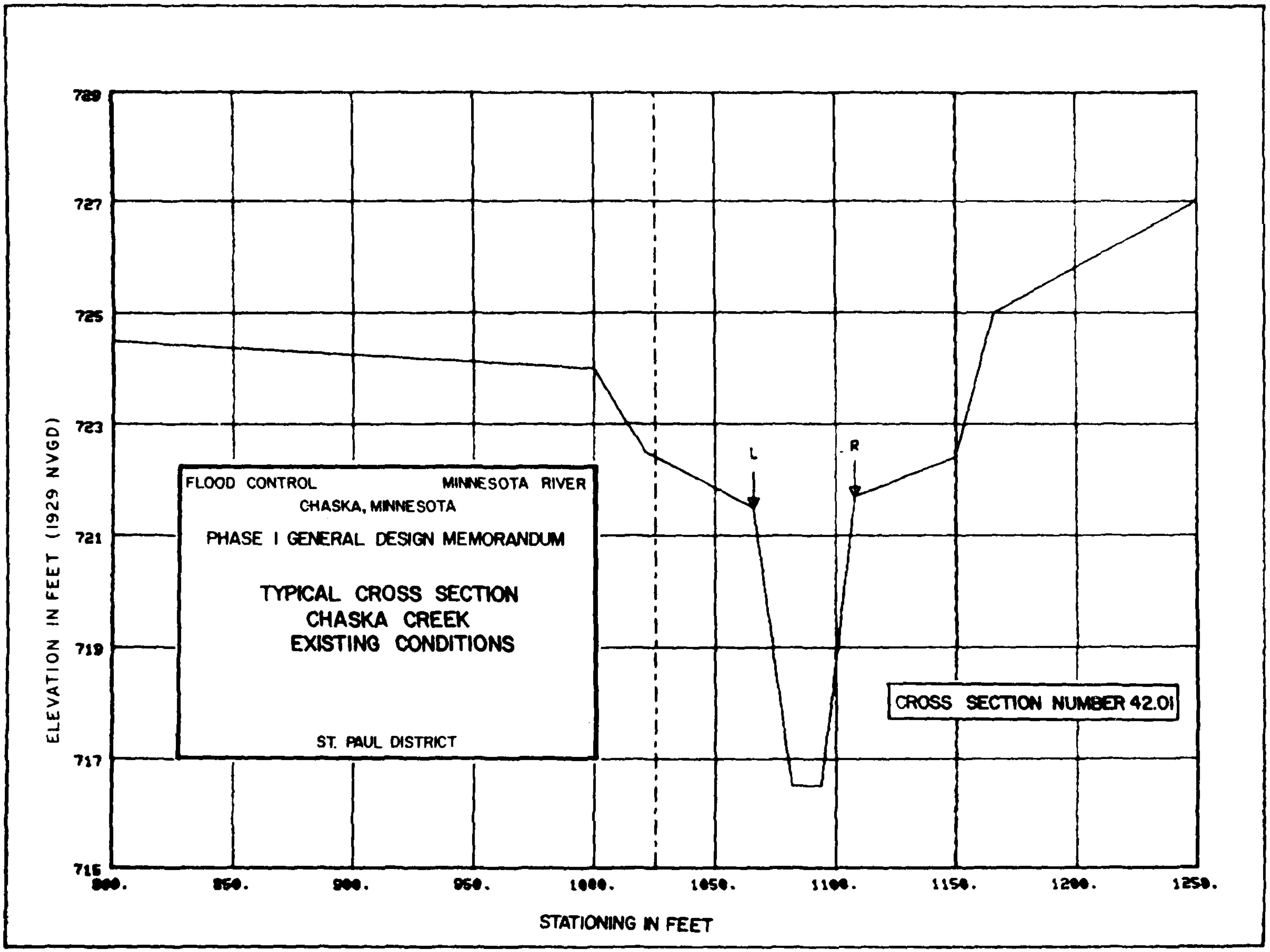
AD-A184 474 MINNESOTA RIVER AT CHASKA MINNESOTA TECHNICAL APENDIXES LIMITED REEVALUA..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT AUG 82

UNCLASSIFIED F/G 13/2 NL



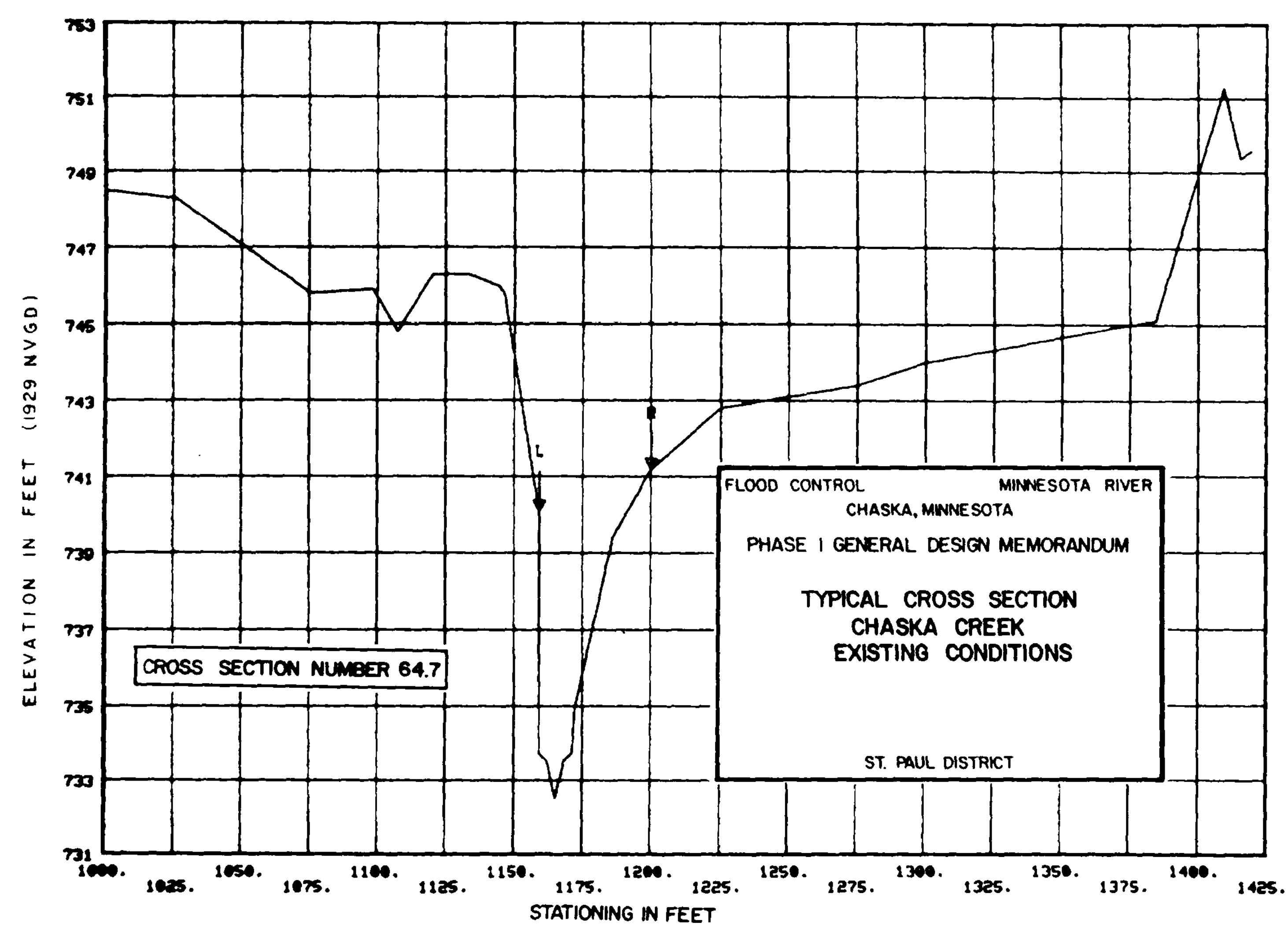


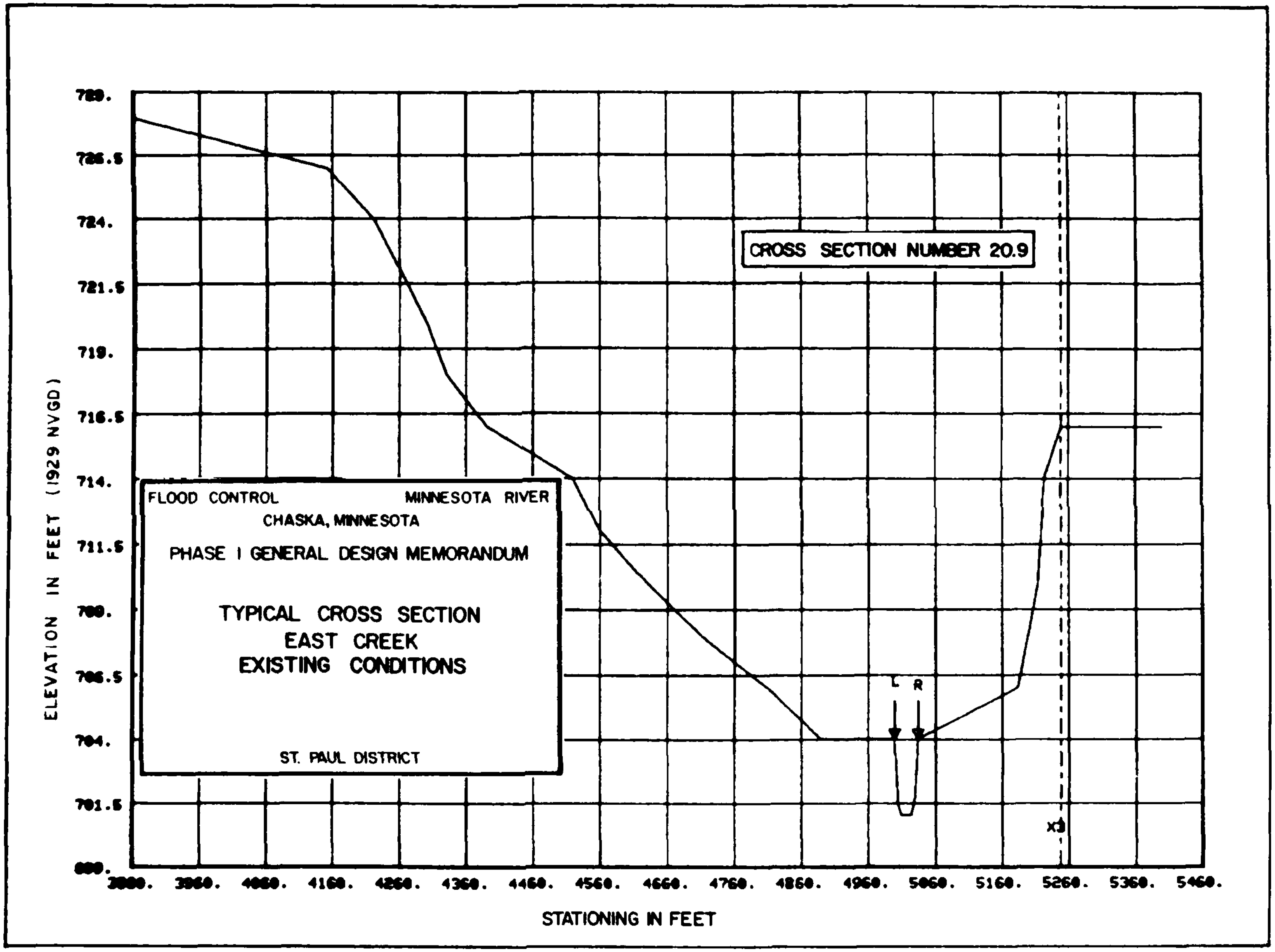
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A



729
727
725
723
721
719
717
715
800.
850.
900.
950.
1000.
1050.
1100.
1150.
1200.
1250.
ELEVATION IN FEET (1929 NVGD)
STATIONING IN FEET
L
R
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
TYPICAL CROSS SECTION
CHASKA CREEK
EXISTING CONDITIONS
ST. PAUL DISTRICT
CROSS SECTION NUMBER 42.01

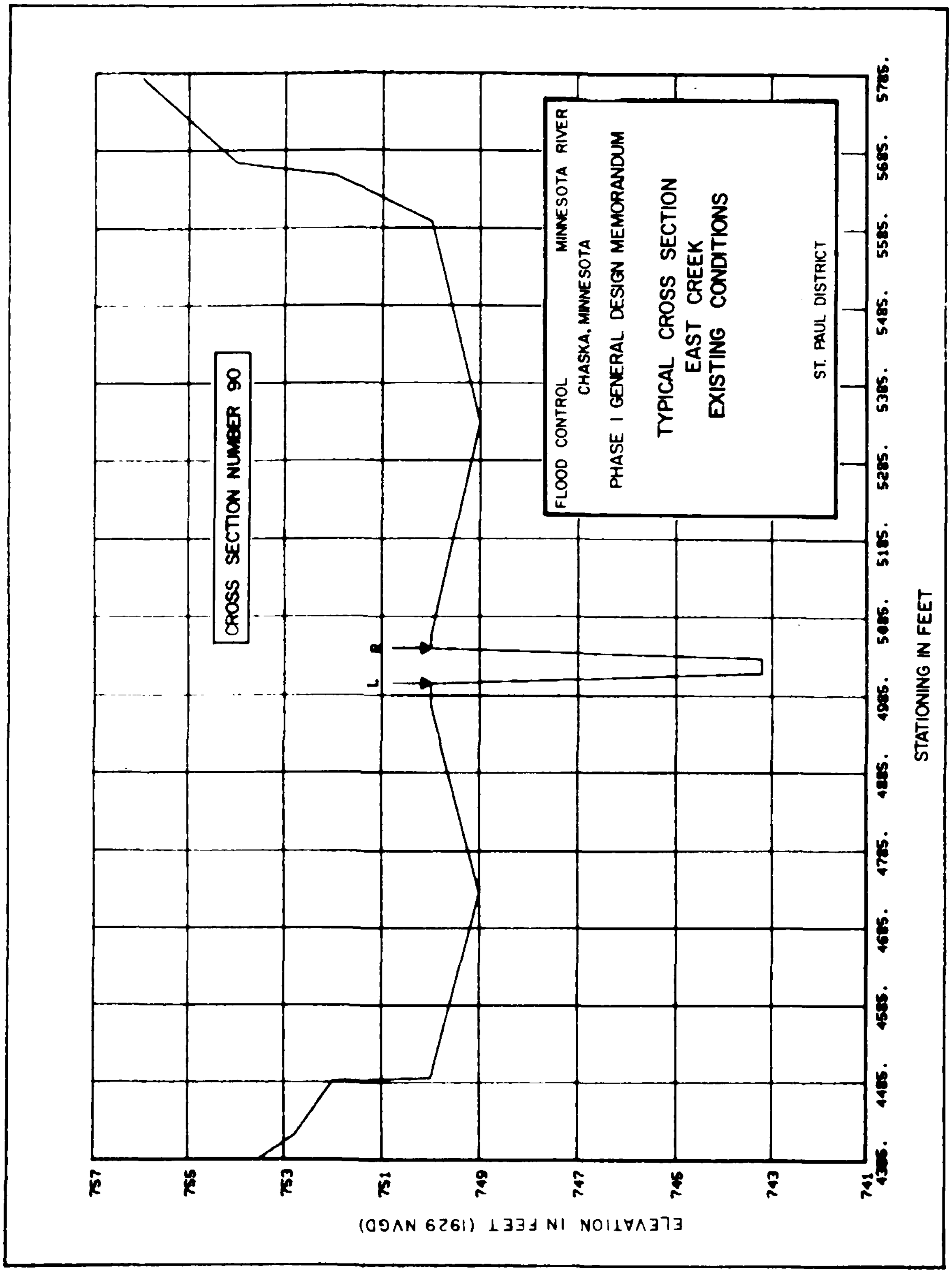
PLATE 4B-12


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
TYPICAL CROSS SECTION
CHASKA CREEK
EXISTING CONDITIONS
ST. PAUL DISTRICT
CROSS SECTION NUMBER 64.7
ELEVATION IN FEET (1929 NVGD)
STATIONING IN FEET
753
751
749
747
745
743
741
739
737
735
733
731
1000.
1025.
1050.
1075.
1100.
1125.
1150.
1175.
1200.
1225.
1250.
1275.
1300.
1325.
1350.
1375.
1400.
1425.
L
R



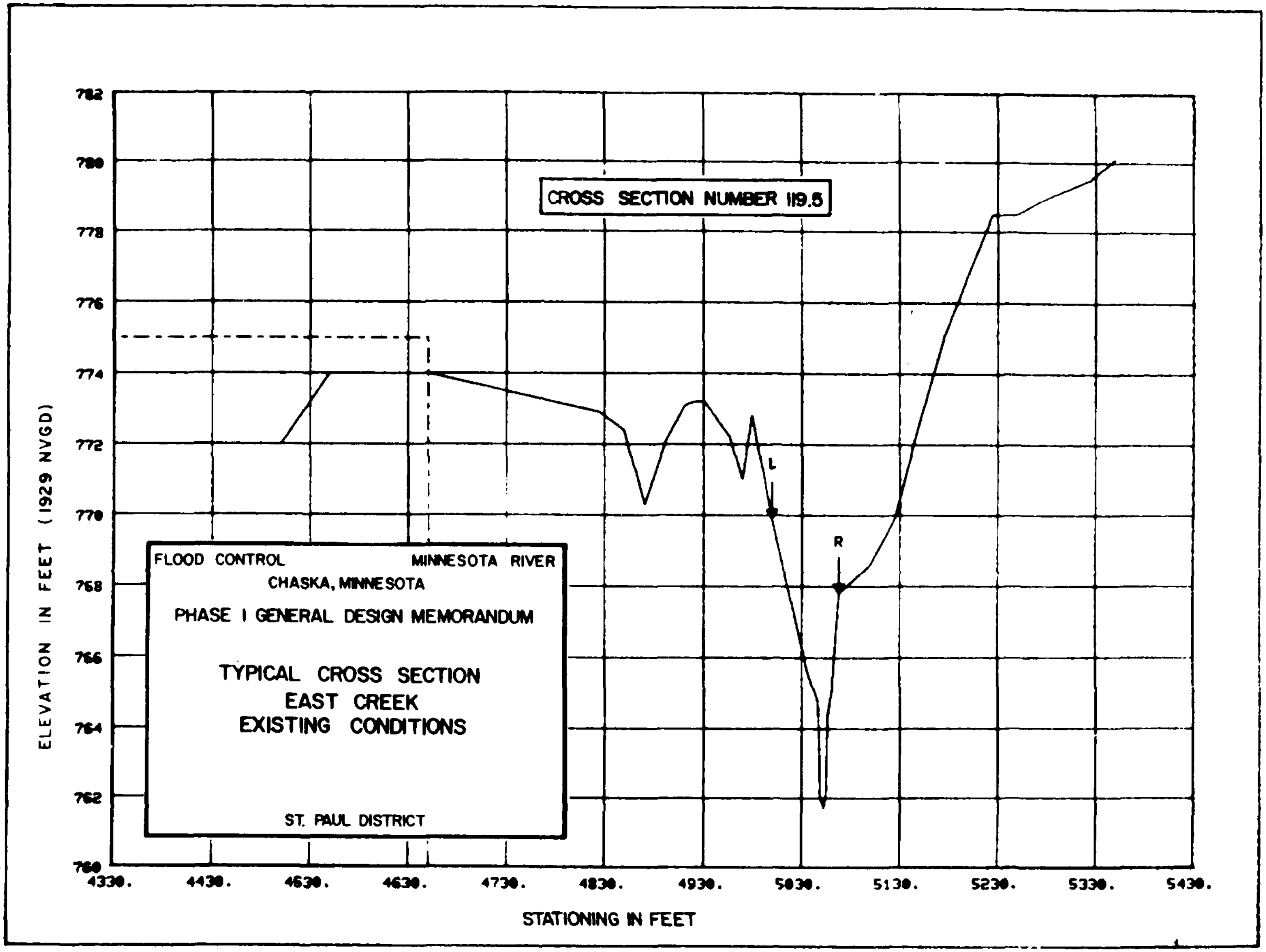
CROSS SECTION NUMBER 20.9
FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
TYPICAL CROSS SECTION
EAST CREEK
EXISTING CONDITIONS
ST. PAUL DISTRICT
ELEVATION IN FEET (1929 NVGD)
729.
726.5
724.
721.5
719.
716.5
714.
711.5
709.
706.5
704.
701.5
699.
3860.
3960.
4060.
4160.
4260.
4360.
4460.
4560.
4660.
4760.
4860.
4960.
5060.
5160.
5260.
5360.
5460.
STATIONING IN FEET
L
R
X3

PLATE 4B-14



CROSS SECTION NUMBER 90
FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
TYPICAL CROSS SECTION
EAST CREEK
EXISTING CONDITIONS
ST. PAUL DISTRICT
L
R
ELEVATION IN FEET (1929 NVGD)
STATIONING IN FEET
757
755
753
751
749
747
745
743
741
4385.
4485.
4585.
4685.
4785.
4885.
4985.
5085.
5185.
5285.
5385.
5485.
5585.
5685.
5785.

PLATE 4B-15



CROSS SECTION NUMBER 119.5
L
R
FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
TYPICAL CROSS SECTION
EAST CREEK
EXISTING CONDITIONS
ST. PAUL DISTRICT
ELEVATION IN FEET (1929 NVGD)
782
780
778
776
774
772
770
768
766
764
762
760
4330.
4430.
4630.
4630.
4730.
4830.
4930.
5030.
5130.
5230.
5330.
5430.
STATIONING IN FEET

PLATE 4B-16

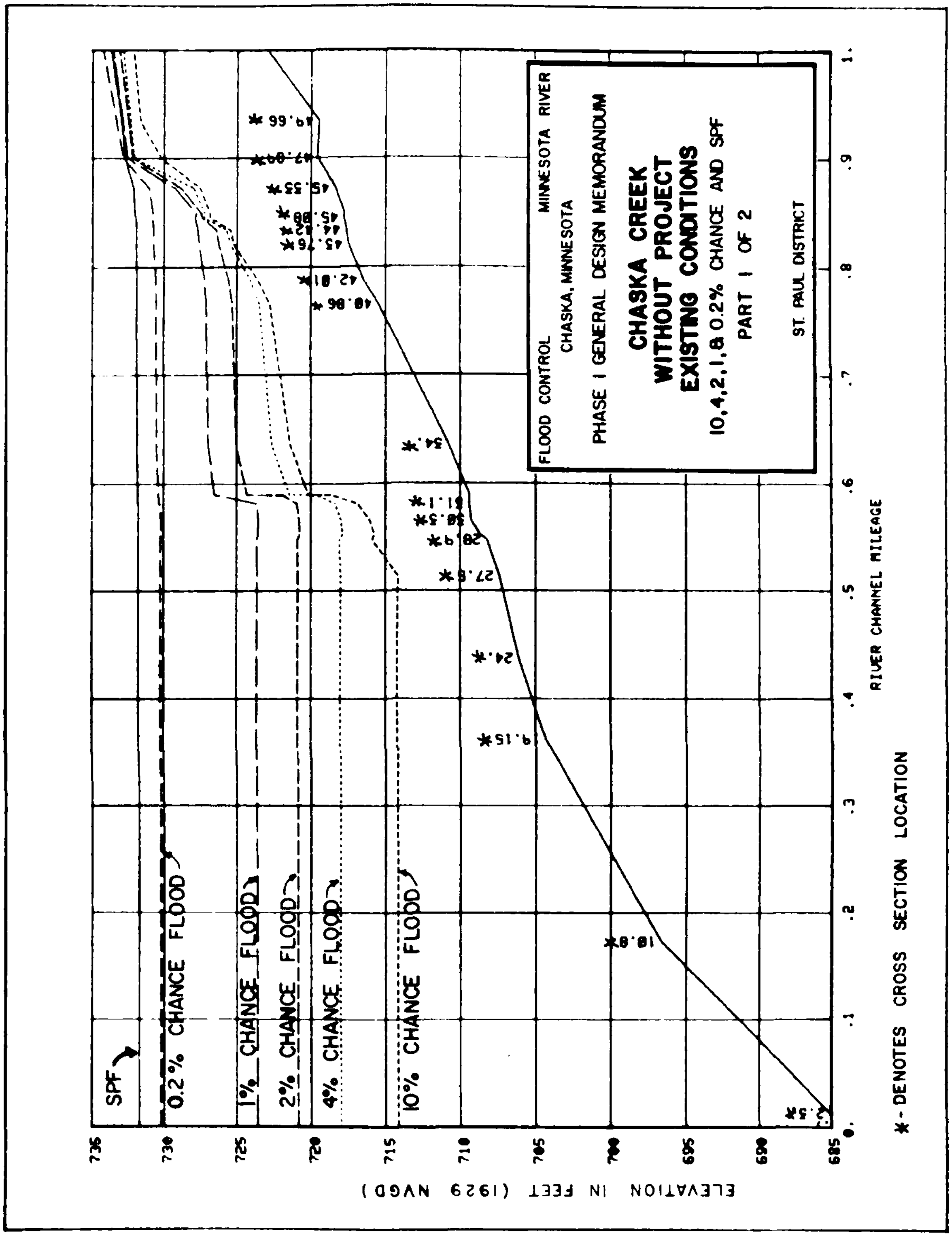
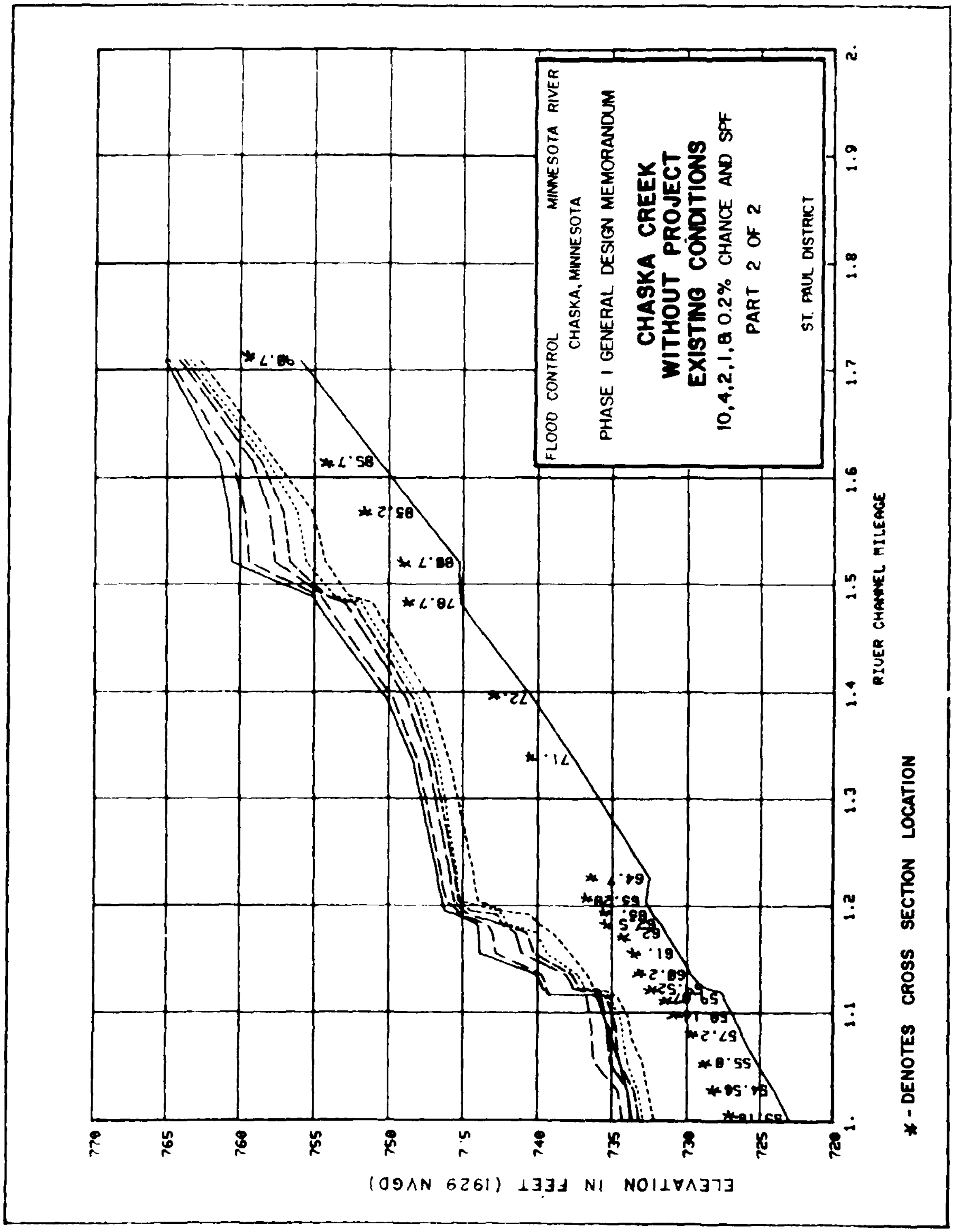

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
CHASKA CREEK
WITHOUT PROJECT
EXISTING CONDITIONS
10,4,2,1,& 0.2% CHANCE AND SPF
PART 1 OF 2
ST. PAUL DISTRICT
SPF
0.2% CHANCE FLOOD
1% CHANCE FLOOD
2% CHANCE FLOOD
4% CHANCE FLOOD
10% CHANCE FLOOD
ELEVATION IN FEET (1929 NVGD)
RIVER CHANNEL MILEAGE
*- DENOTES CROSS SECTION LOCATION

PLATE 4B-17



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
CHASKA CREEK
WITHOUT PROJECT
EXISTING CONDITIONS
10,4,2,1,& 0.2% CHANCE AND SPF
PART 2 OF 2
ST. PAUL DISTRICT
ELEVATION IN FEET (1929 NVGD)
RIVER CHANNEL MILEAGE
✱-DENOTES CROSS SECTION LOCATION

PLATE 4B-18

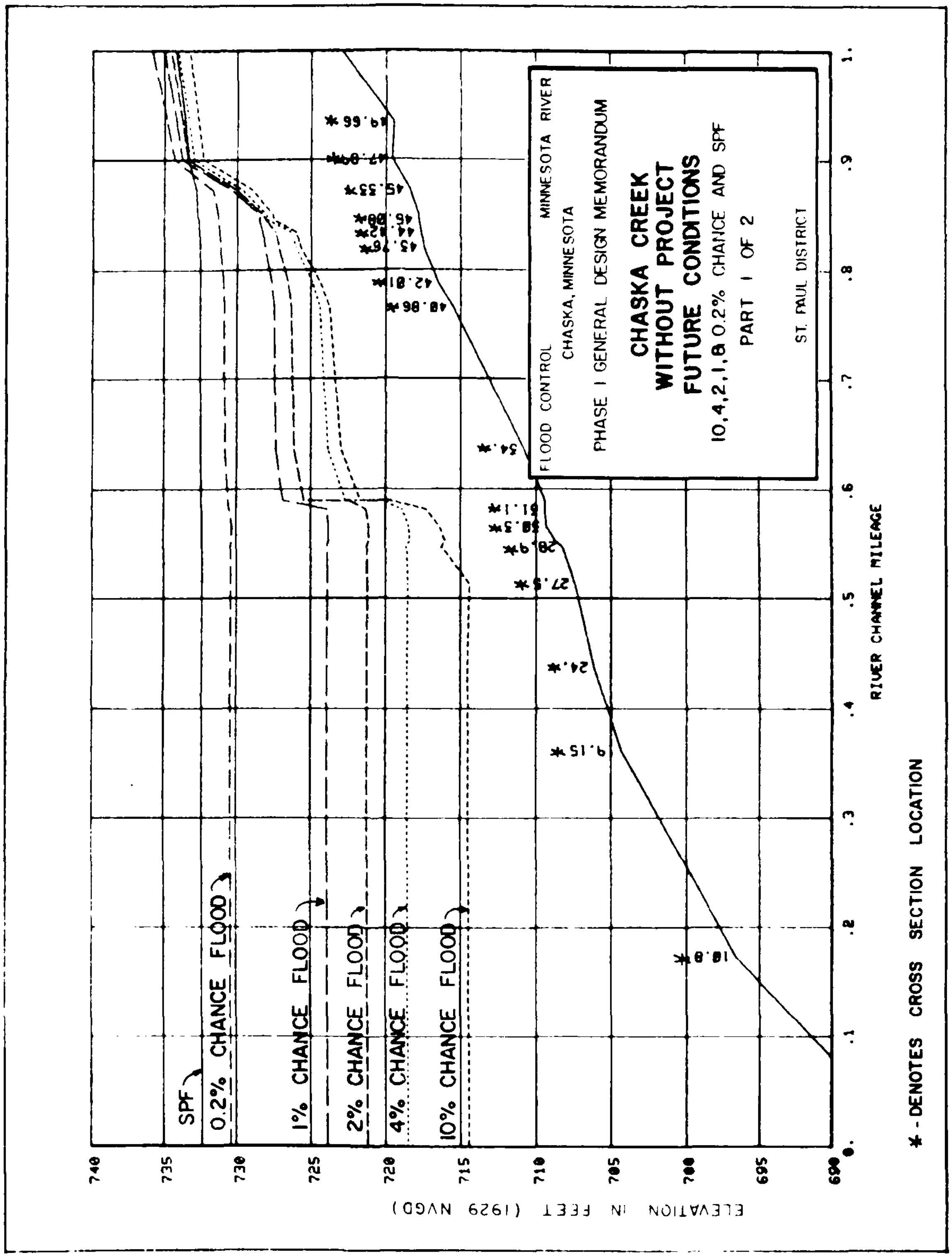
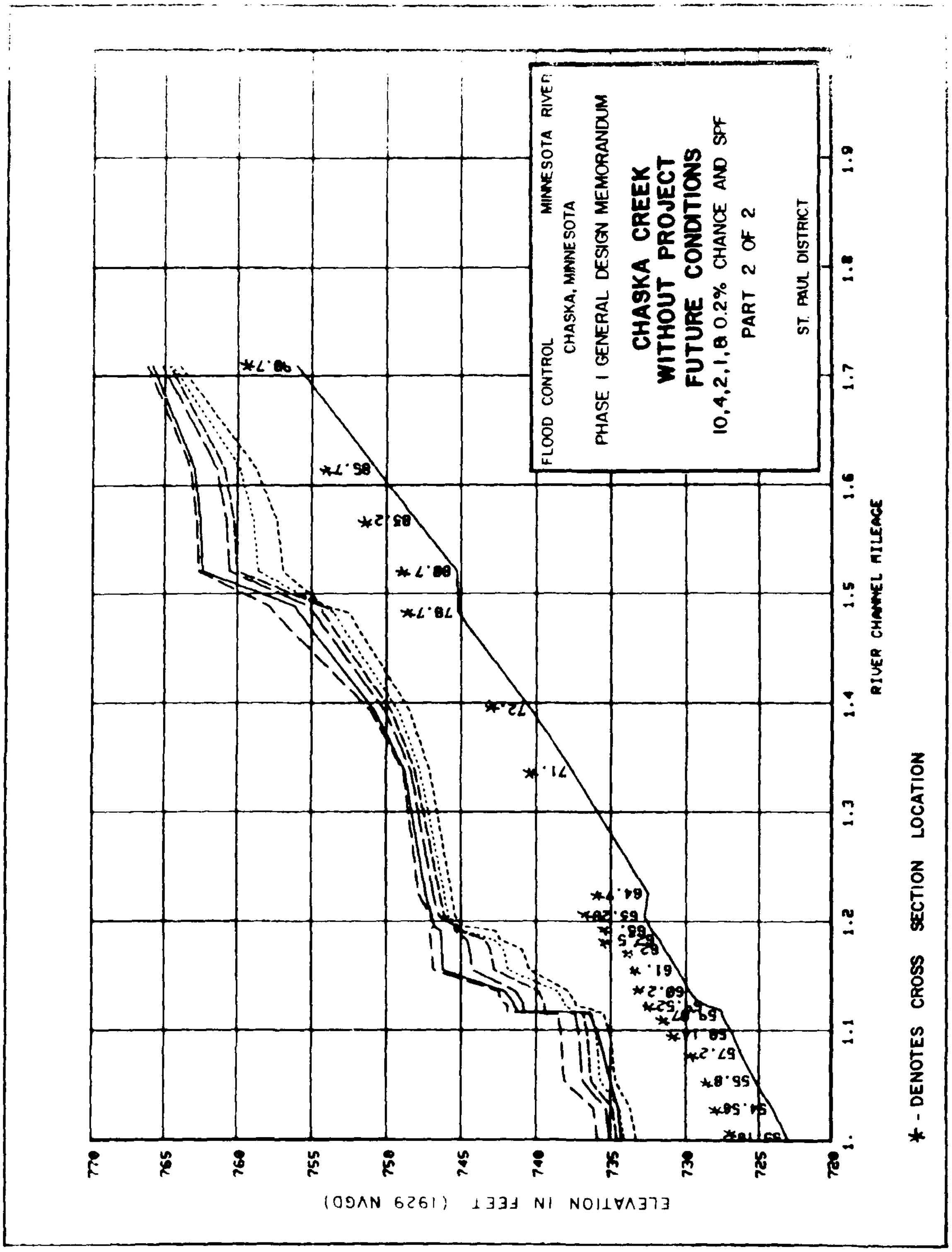

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
CHASKA CREEK
WITHOUT PROJECT
FUTURE CONDITIONS
10,4,2,1,& 0.2% CHANCE AND SPF
PART 1 OF 2
ST. PAUL DISTRICT
SPF
0.2% CHANCE FLOOD
1% CHANCE FLOOD
2% CHANCE FLOOD
4% CHANCE FLOOD
10% CHANCE FLOOD
ELEVATION IN FEET (1929 NVGD)
RIVER CHANNEL MILEAGE
* - DENOTES CROSS SECTION LOCATION

PLATE 4B-19



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
CHASKA CREEK
WITHOUT PROJECT
FUTURE CONDITIONS
10,4,2,1,& 0.2% CHANCE AND SPF
PART 2 OF 2
ST. PAUL DISTRICT
ELEVATION IN FEET (1929 NVGD)
RIVER CHANNEL MILEAGE
* - DENOTES CROSS SECTION LOCATION

PLATE 4B-20

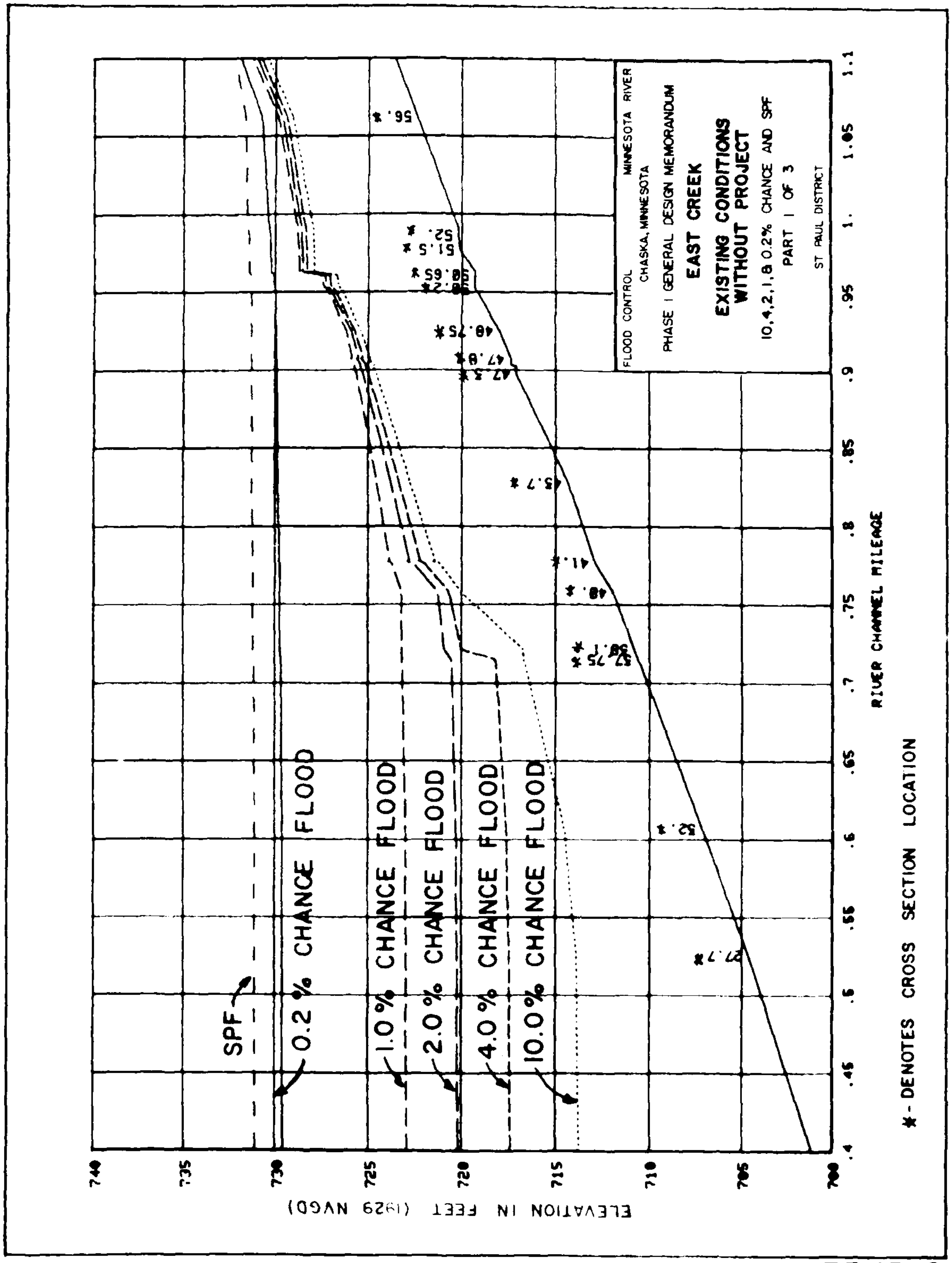
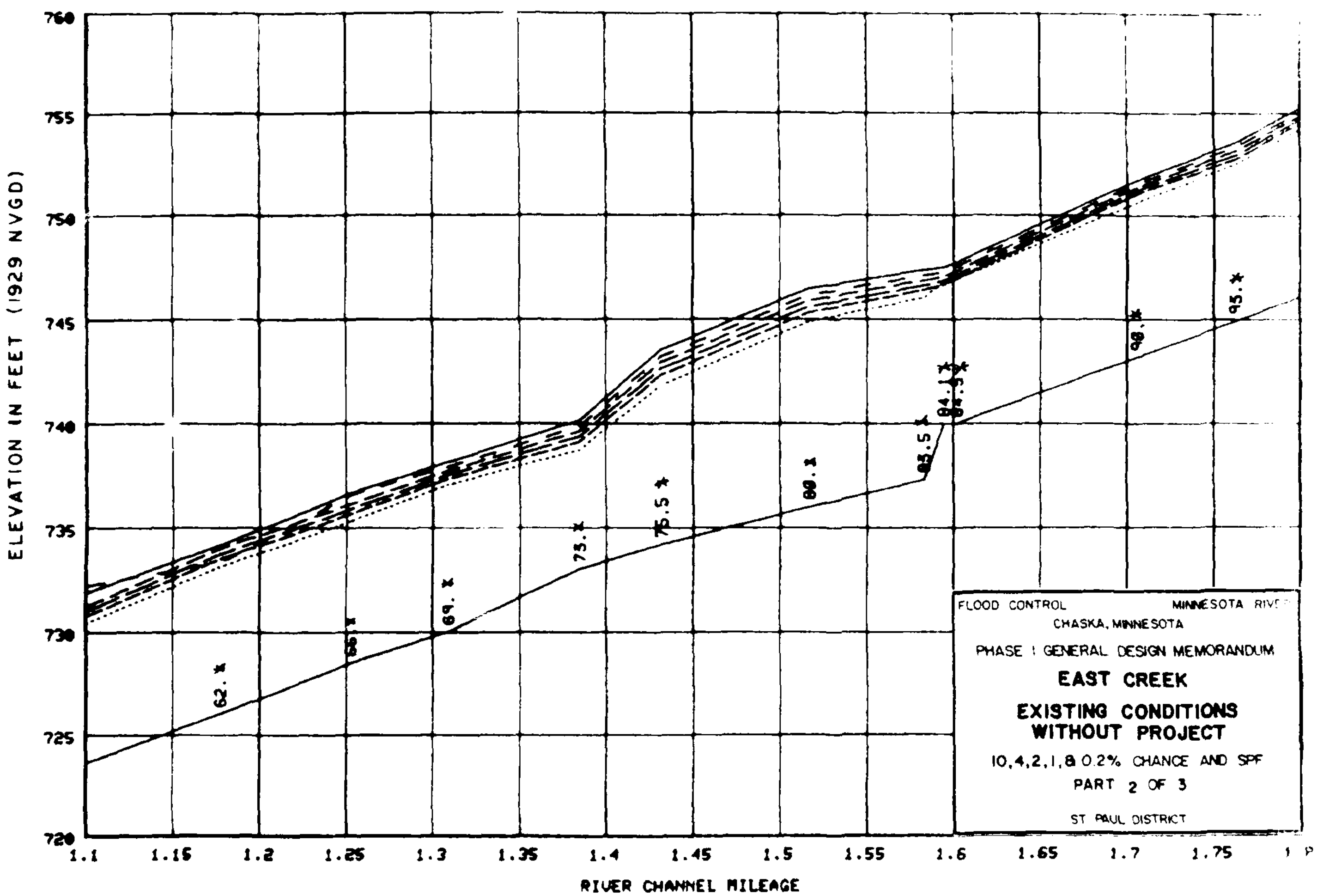

FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
EAST CREEK
EXISTING CONDITIONS WITHOUT PROJECT
10, 4, 2, 1, & 0.2% CHANCE AND SPF
PART 1 OF 3
ST PAUL DISTRICT
SPF
0.2% CHANCE FLOOD
1.0% CHANCE FLOOD
2.0% CHANCE FLOOD
4.0% CHANCE FLOOD
10.0% CHANCE FLOOD
ELEVATION IN FEET (1929 NVGD)
RIVER CHANNEL MILEAGE
CROSS SECTION LOCATION
*- DENOTES CROSS SECTION LOCATION

PLATE 4B-21



*- DENOTES CROSS SECTION LOCATION

PLATE 4B-22

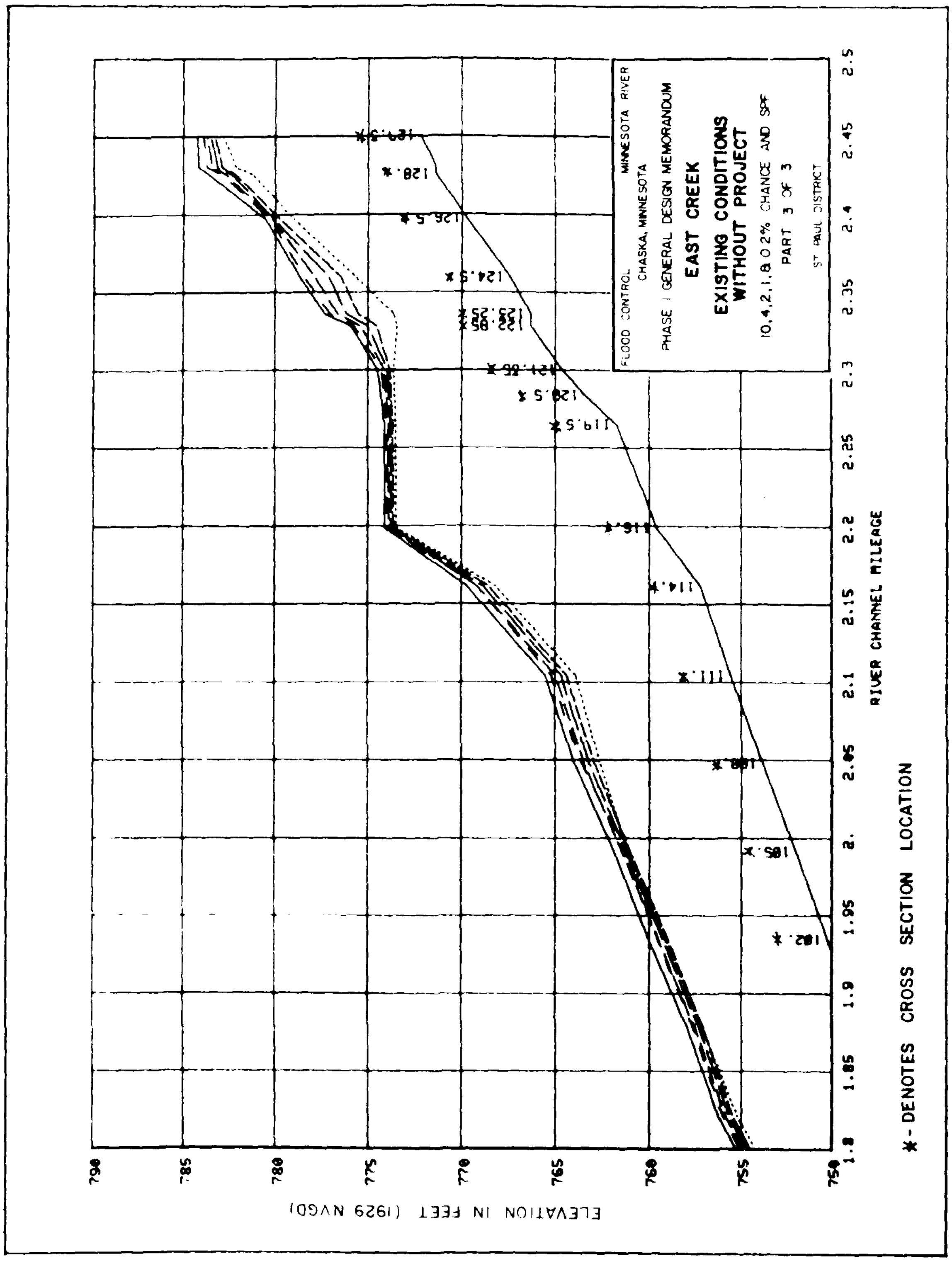

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
EAST CREEK
EXISTING CONDITIONS
WITHOUT PROJECT
10,4,2,1,& 0.2% CHANCE AND SPF
PART 3 OF 3
ST PAUL DISTRICT
ELEVATION IN FEET (1929 NVGD)
790
785
780
775
770
765
760
755
750
RIVER CHANNEL MILEAGE
1.8
1.85
1.9
1.95
2.
2.05
2.1
2.15
2.2
2.25
2.3
2.35
2.4
2.45
2.5
102.
105.
108.
111.
114.
116.
119.5
120.5
121.65
122.85
123.25
124.5
126.5
128.
129.5
*-DENOTES CROSS SECTION LOCATION

PLATE 4B-23

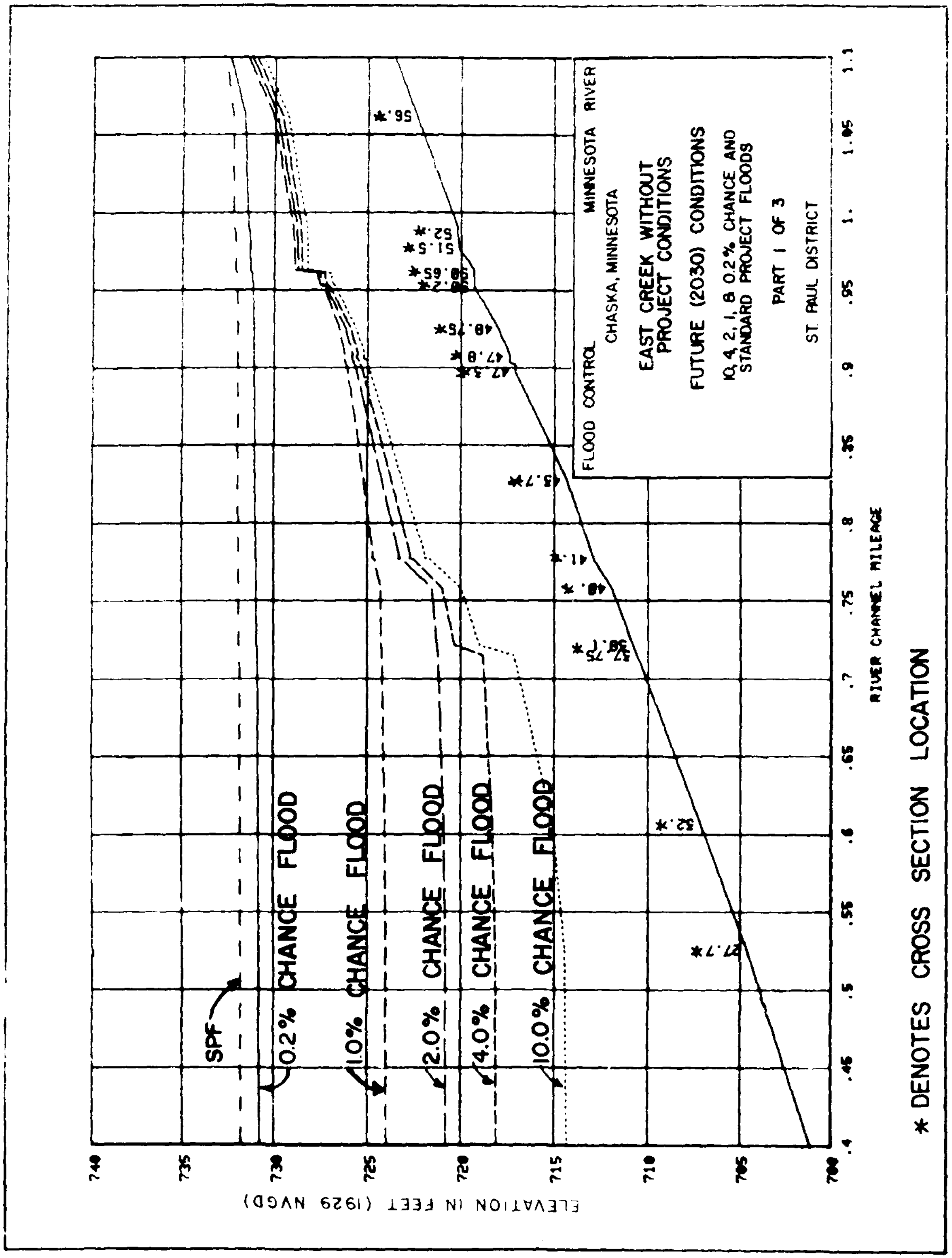

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
EAST CREEK WITHOUT PROJECT CONDITIONS
FUTURE (2030) CONDITIONS
10, 4, 2, 1, & 0.2% CHANCE AND STANDARD PROJECT FLOODS
PART 1 OF 3
ST PAUL DISTRICT
SPF
0.2% CHANCE FLOOD
1.0% CHANCE FLOOD
2.0% CHANCE FLOOD
4.0% CHANCE FLOOD
10.0% CHANCE FLOOD
ELEVATION IN FEET (1929 NVGD)
RIVER CHANNEL MILEAGE
* DENOTES CROSS SECTION LOCATION

PLATE 4B-24

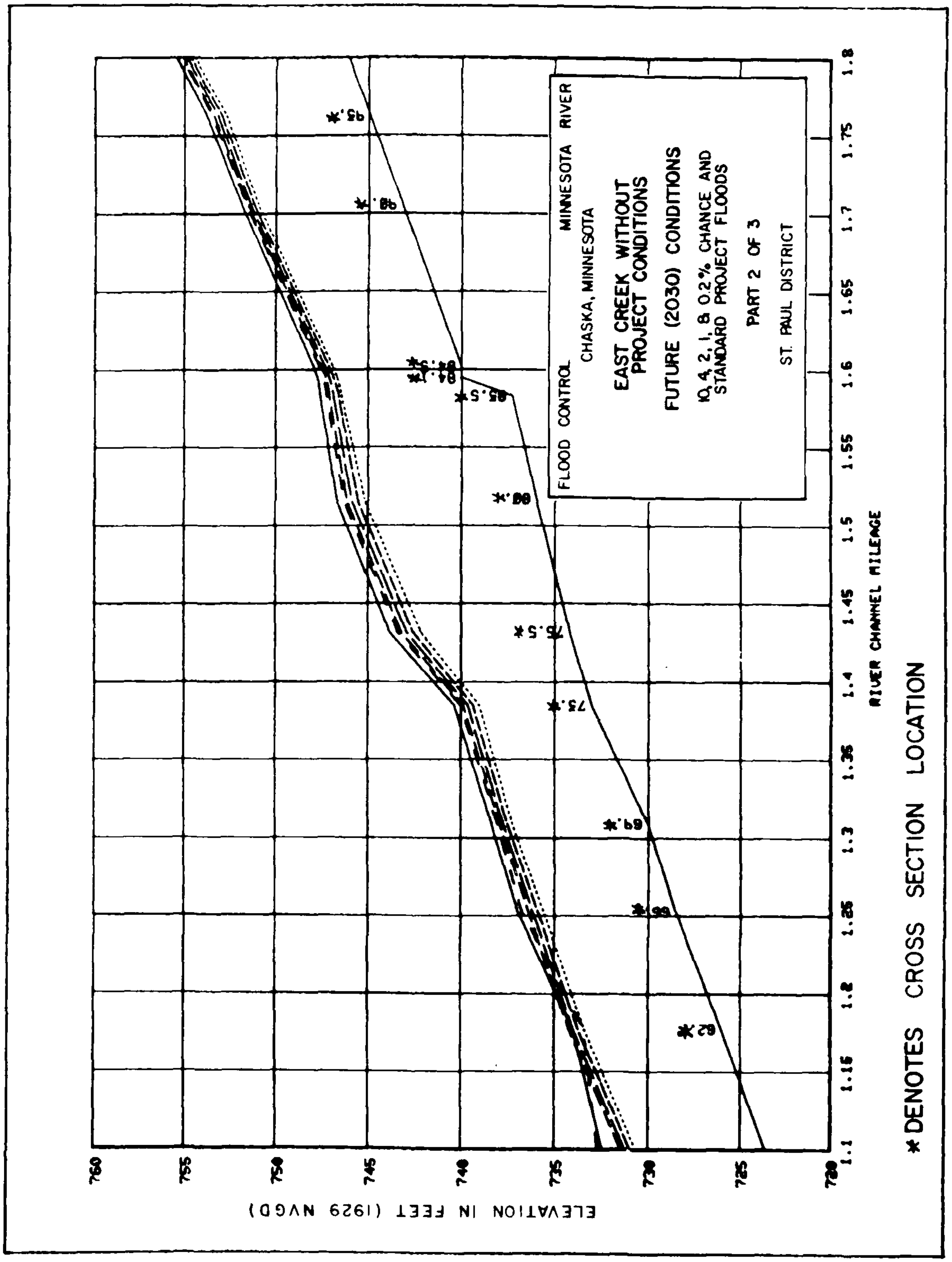

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
EAST CREEK WITHOUT PROJECT CONDITIONS
FUTURE (2030) CONDITIONS
10, 4, 2, 1, & 0.2% CHANCE AND STANDARD PROJECT FLOODS
PART 2 OF 3
ST. PAUL DISTRICT
ELEVATION IN FEET (1929 NVGD)
RIVER CHANNEL MILEAGE
*DENOTES CROSS SECTION LOCATION

PLATE 4B-25

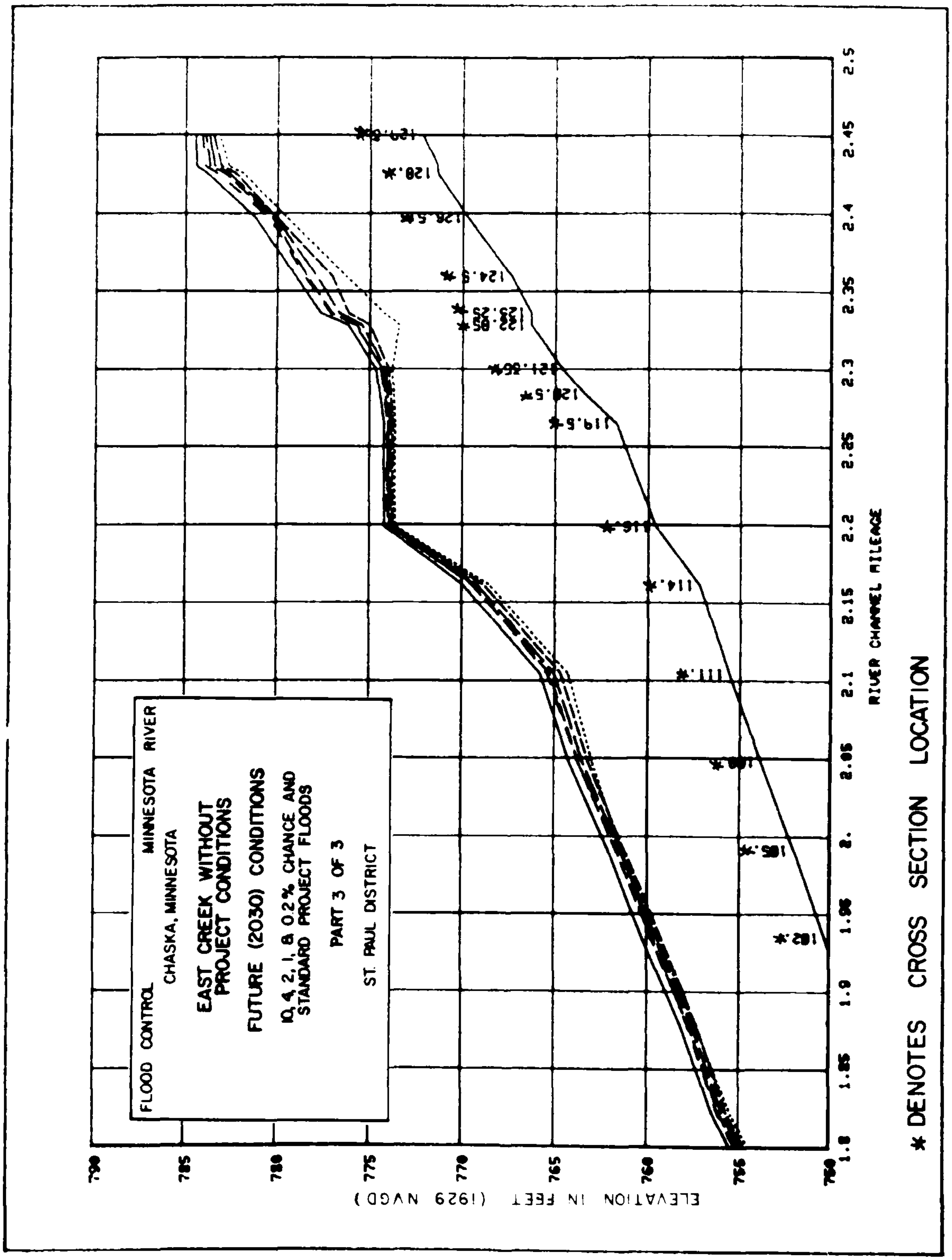

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
EAST CREEK WITHOUT PROJECT CONDITIONS
FUTURE (2030) CONDITIONS
10, 4, 2, 1, & 0.2% CHANCE AND STANDARD PROJECT FLOODS
PART 3 OF 3
ST. PAUL DISTRICT
ELEVATION IN FEET (1929 NVGD)
RIVER CHANNEL MILEAGE
* DENOTES CROSS SECTION LOCATION
750
755
760
765
770
775
780
785
790
1.8
1.85
1.9
1.95
2.
2.05
2.1
2.15
2.2
2.25
2.3
2.35
2.4
2.45
2.5

PLATE 4B-26

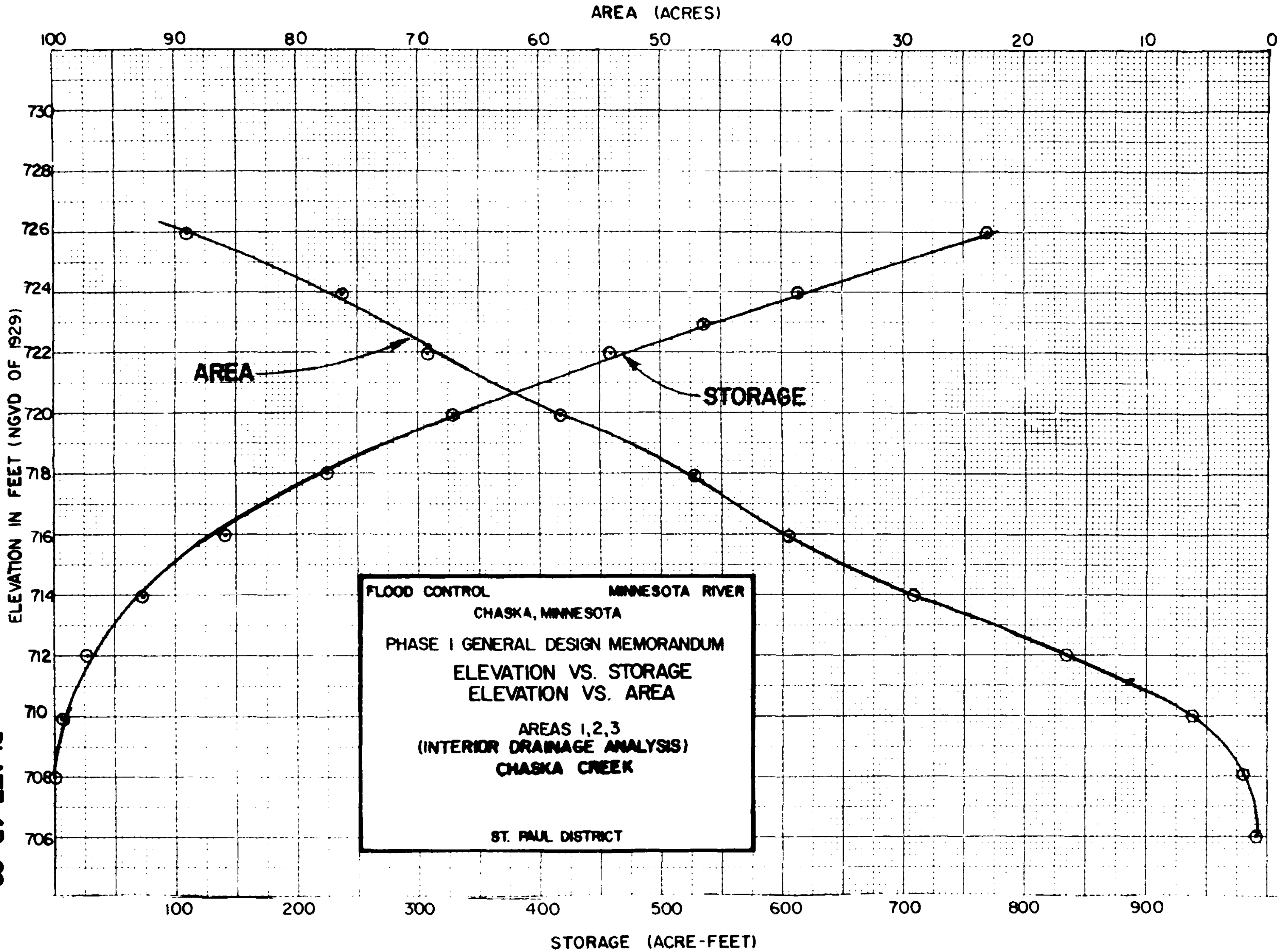

AREA (ACRES)
100 90 80 70 60 50 40 30 20 10 0
ELEVATION IN FEET (NGVD OF 1929)
730 728 726 724 722 720 718 716 714 712 710 708 706
AREA
STORAGE
100 200 300 400 500 600 700 800 900
STORAGE (ACRE-FEET)
FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
ELEVATION VS. STORAGE
ELEVATION VS. AREA
AREAS 1,2,3
(INTERIOR DRAINAGE ANALYSIS)
CHASKA CREEK
ST. PAUL DISTRICT

PLATE 4B-29

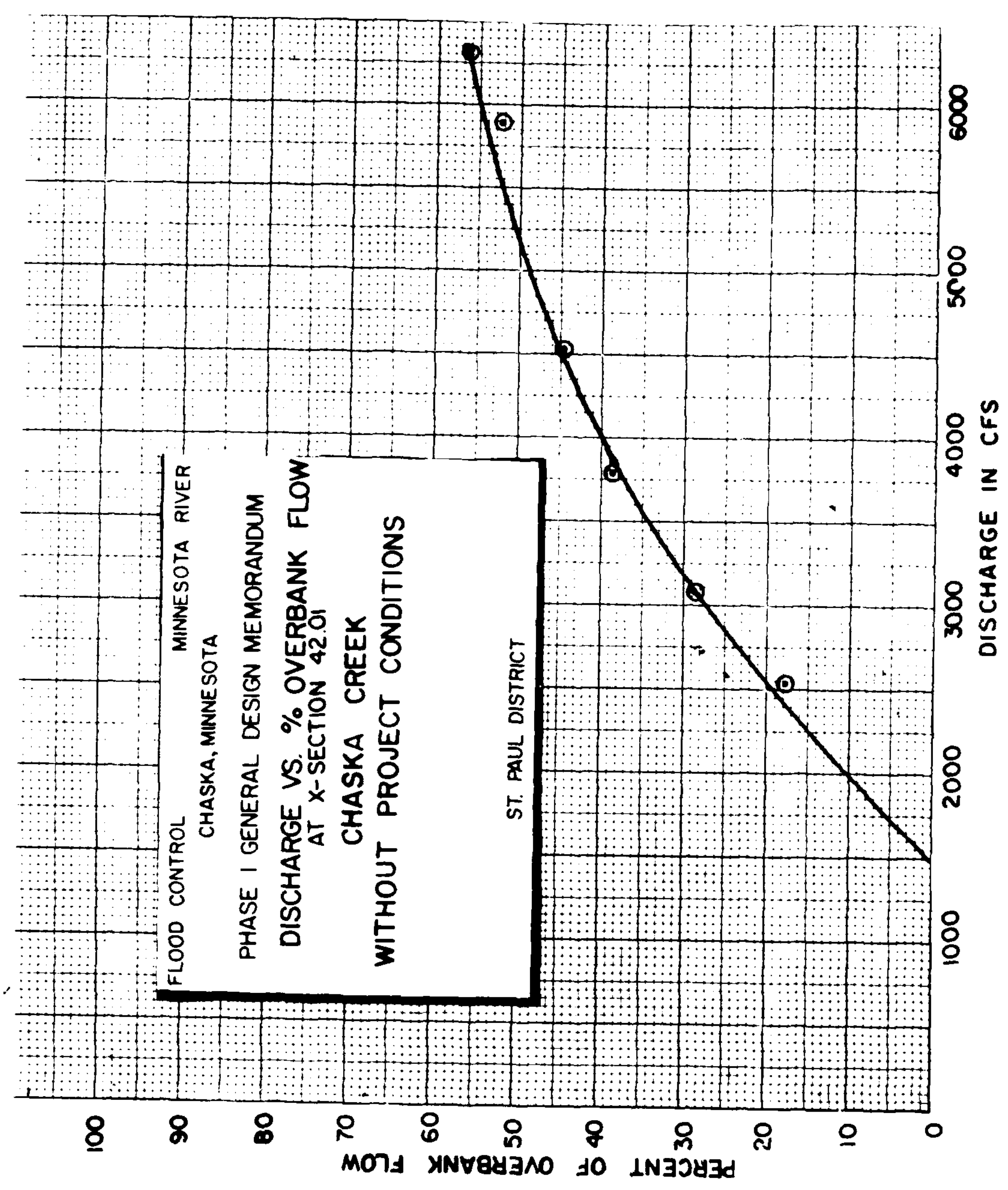

FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
DISCHARGE VS. % OVERBANK FLOW
AT X-SECTION 42.01
CHASKA CREEK
WITHOUT PROJECT CONDITIONS
ST. PAUL DISTRICT
PERCENT OF OVERBANK FLOW
100
90
80
70
60
50
40
30
20
10
0
1000
2000
3000
4000
5000
6000
DISCHARGE IN CFS

PLATE 48-30

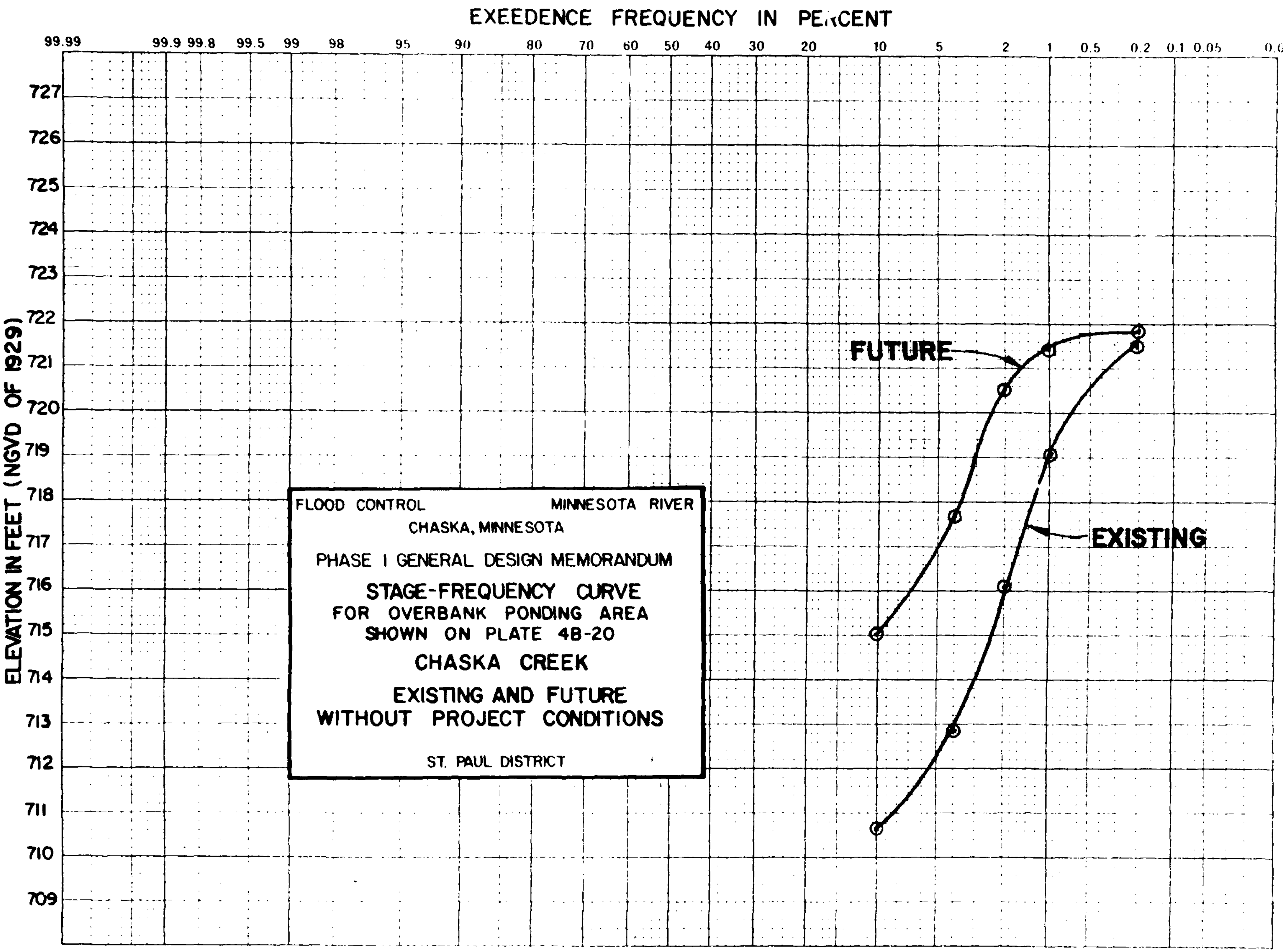

EXEEDENCE FREQUENCY IN PERCENT
99.99 99.9 99.8 99.5 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
ELEVATION IN FEET (NGVD OF 1929)
727 726 725 724 723 722 721 720 719 718 717 716 715 714 713 712 711 710 709
FUTURE
EXISTING
FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
STAGE-FREQUENCY CURVE
FOR OVERBANK PONDING AREA
SHOWN ON PLATE 4B-20
CHASKA CREEK
EXISTING AND FUTURE
WITHOUT PROJECT CONDITIONS
ST. PAUL DISTRICT

PLATE 4B-31

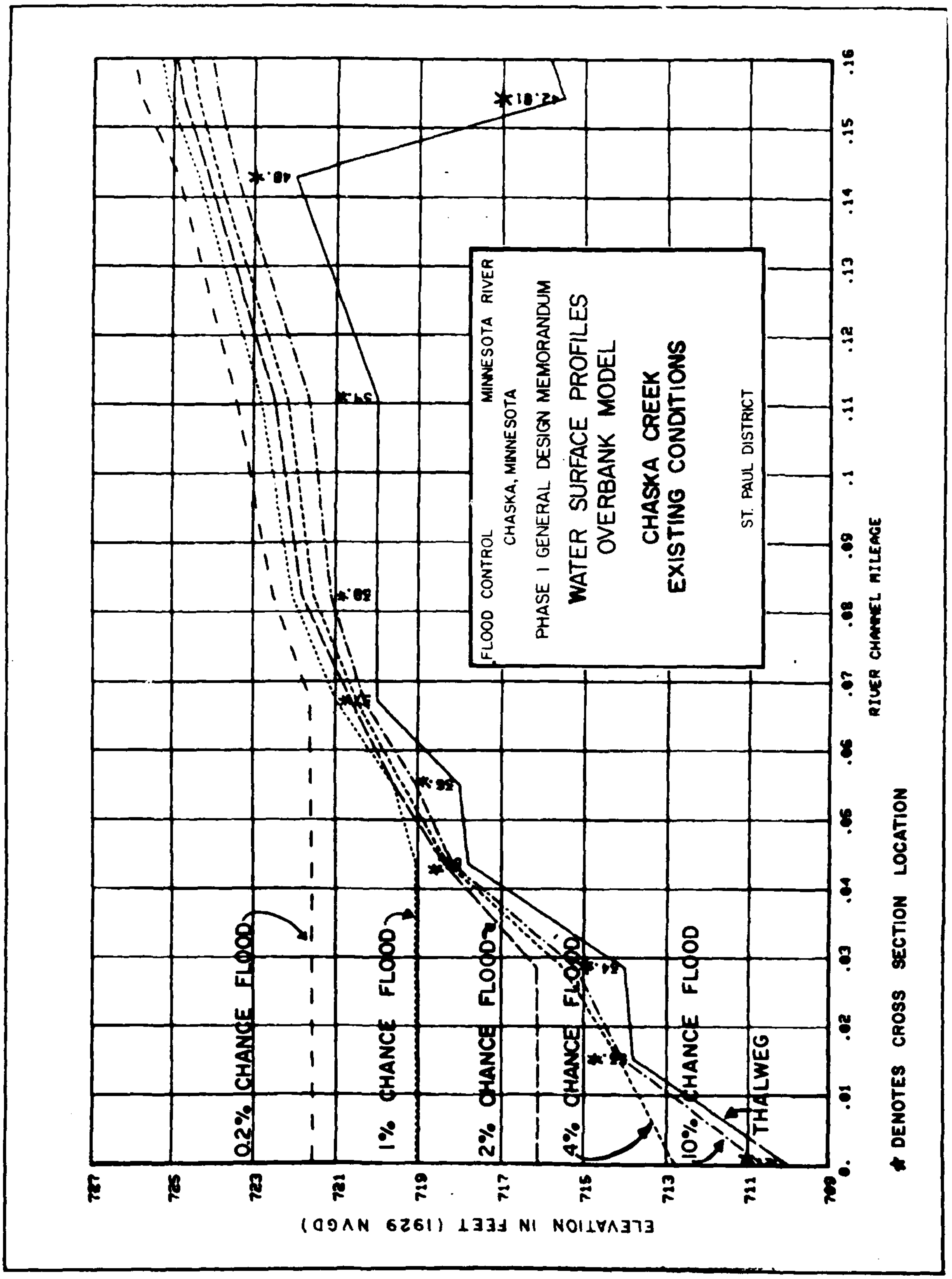
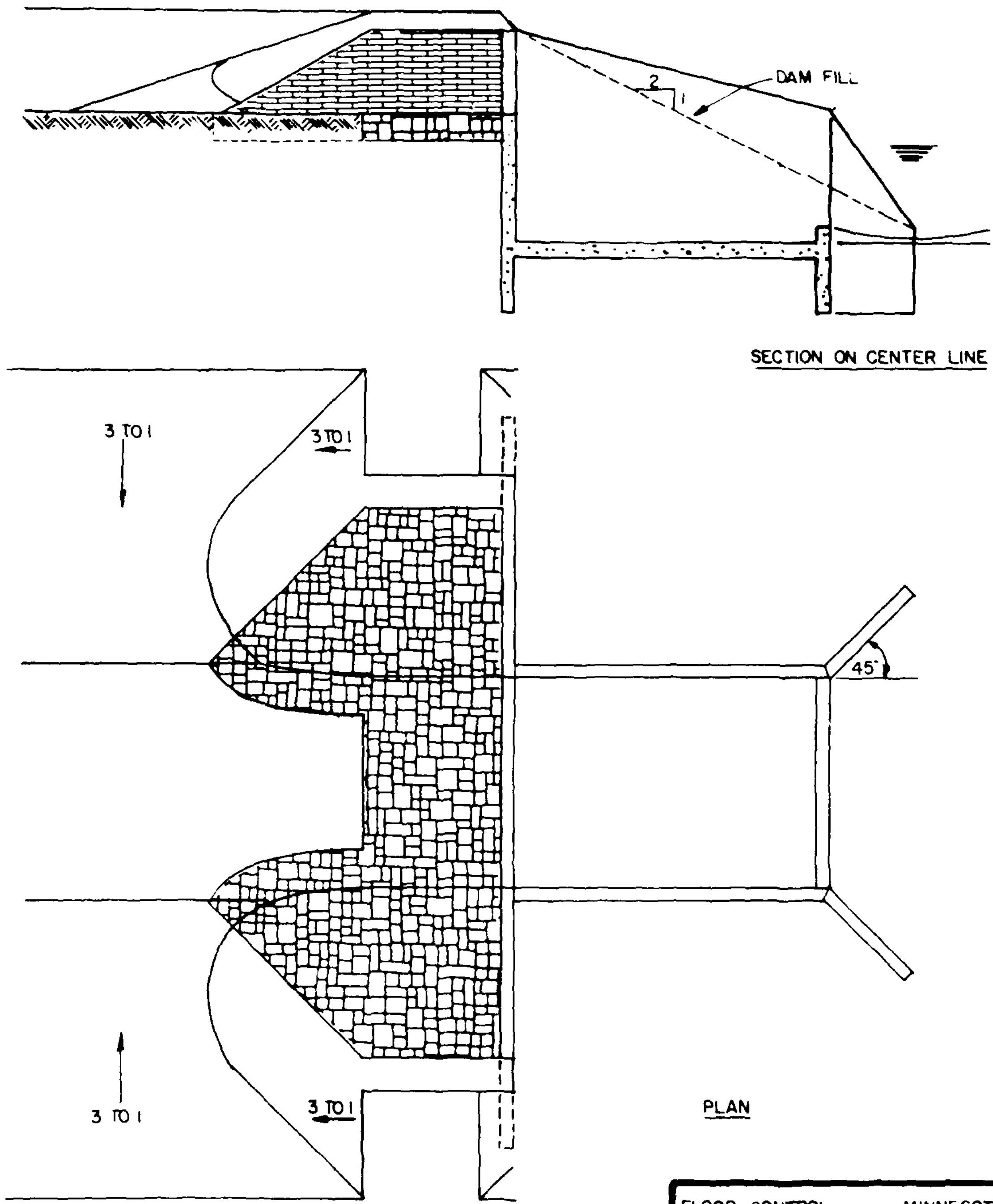

FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
WATER SURFACE PROFILES
OVERBANK MODEL
CHASKA CREEK
EXISTING CONDITIONS
ST. PAUL DISTRICT
0.2% CHANCE FLOOD
1% CHANCE FLOOD
2% CHANCE FLOOD
4% CHANCE FLOOD
10% CHANCE FLOOD
THALWEG
ELEVATION IN FEET (1929 NVGD)
709
711
713
715
717
719
721
723
725
727
RIVER CHANNEL MILEAGE
0. .01 .02 .03 .04 .05 .06 .07 .08 .09 .1 .11 .12 .13 .14 .15 .16
* DENOTES CROSS SECTION LOCATION

PLATE 4B-32

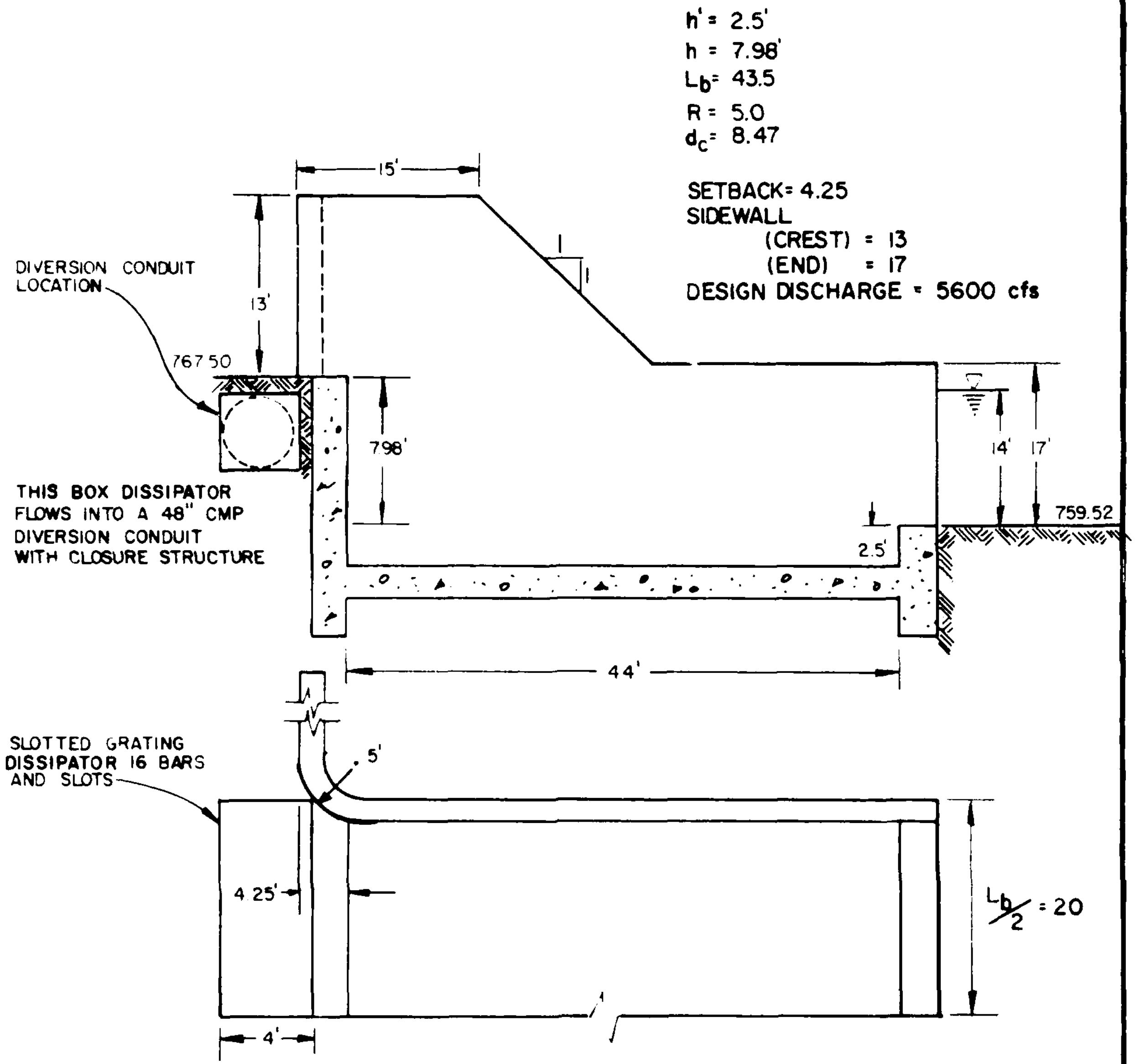


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

TYPICAL PLAN VIEW AND SECTION OF PROPOSED DROP STRUCTURES

ST. PAUL DISTRICT



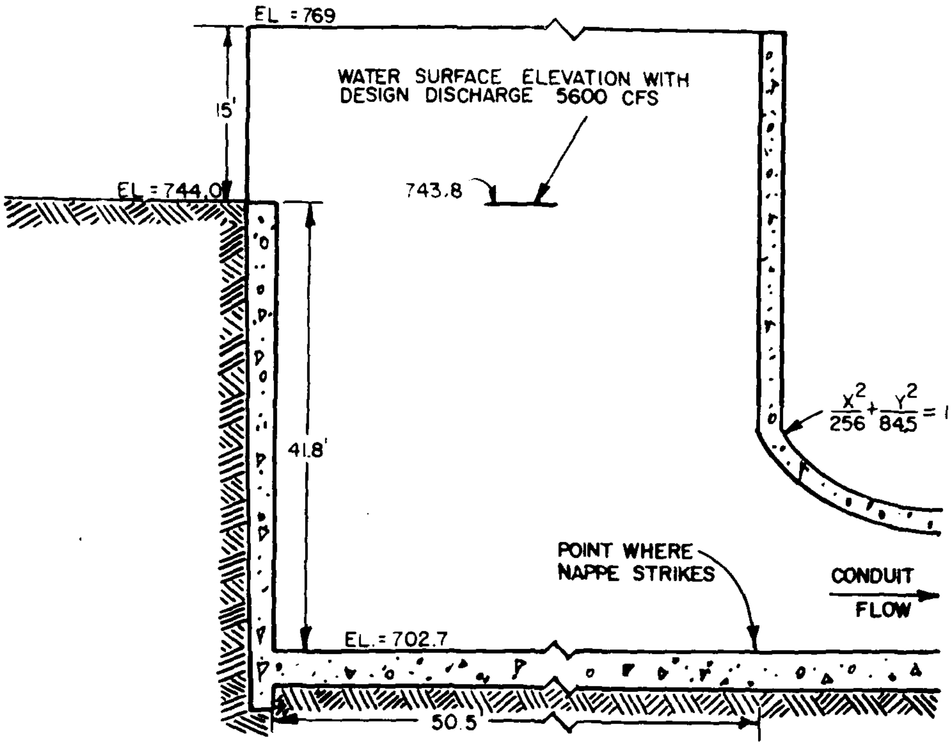
NOT TO SCALE

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

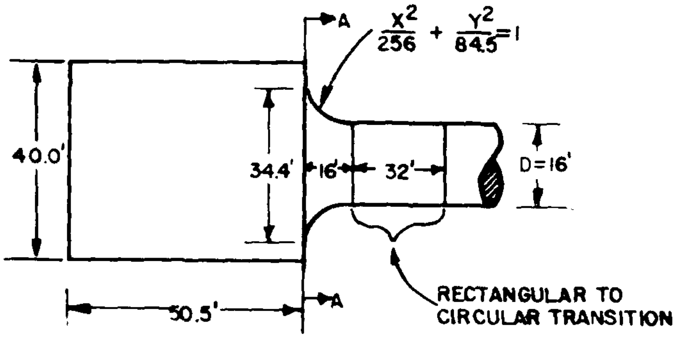
PHASE I GENERAL DESIGN MEMORANDUM

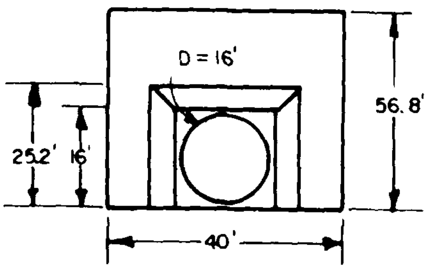
DROP STRUCTURE
STATION 48+60
PROPOSED
EAST CREEK
DIVERSION STRUCTURE

ST. PAUL DISTRICT



PLAN VIEW





SECTION-A

NOT TO SCALE

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

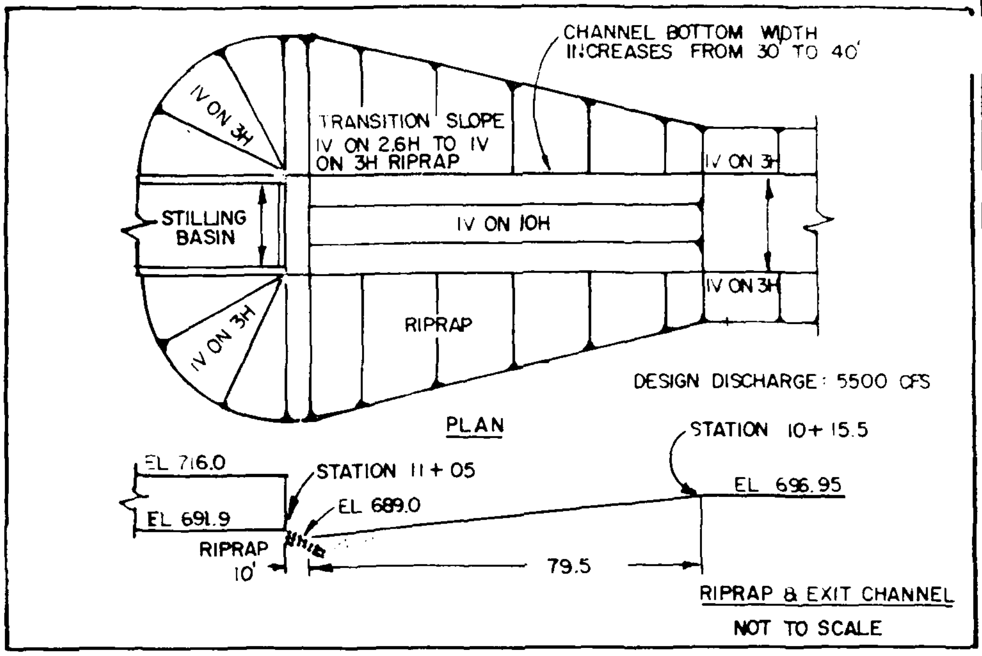
DROP STRUCTURE AND PROPOSED TUNNEL WORKS

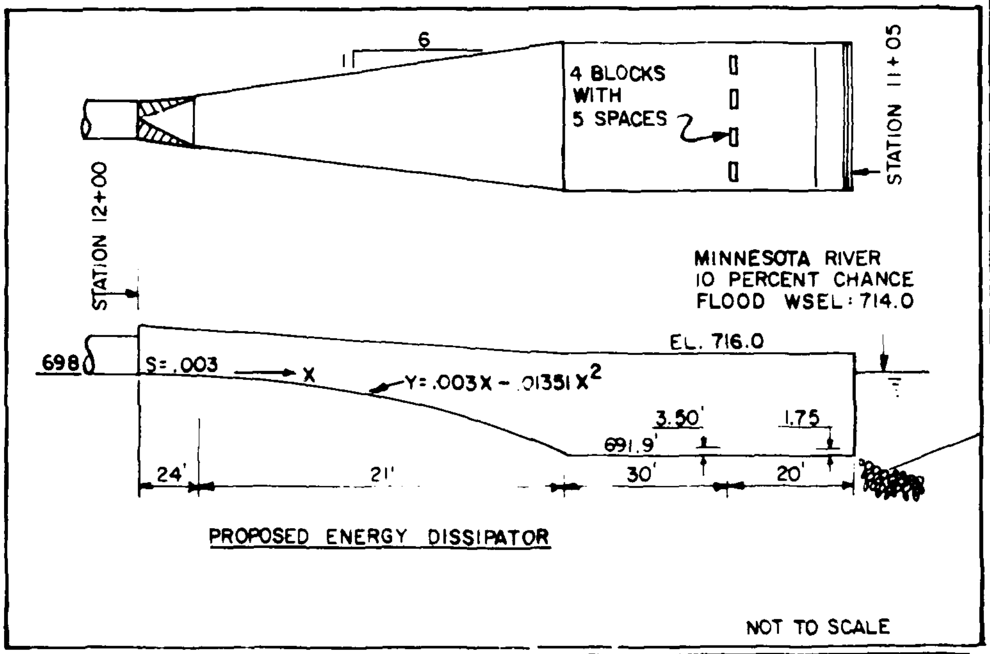
STATION 26+60

EAST CREEK

ST. PAUL DISTRICT

PROPOSED RIPRAP AND EXIT CHANNEL FOR PROPOSED ENERGY DISSIPATOR



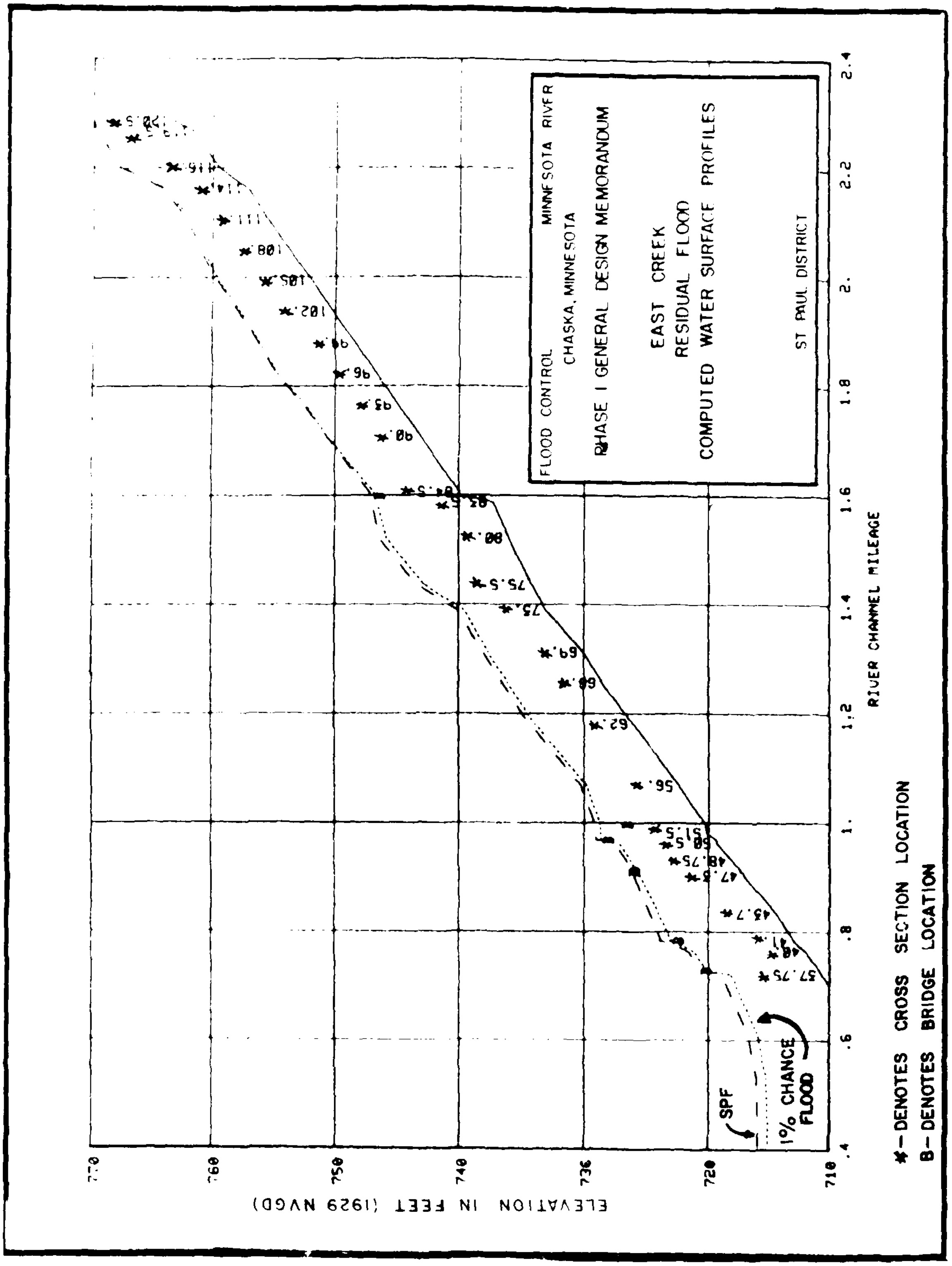


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

PROPOSED EXIT CHANNEL AND ENERGY DISSIPATOR

EAST CREEK

ST. PAUL DISTRICT

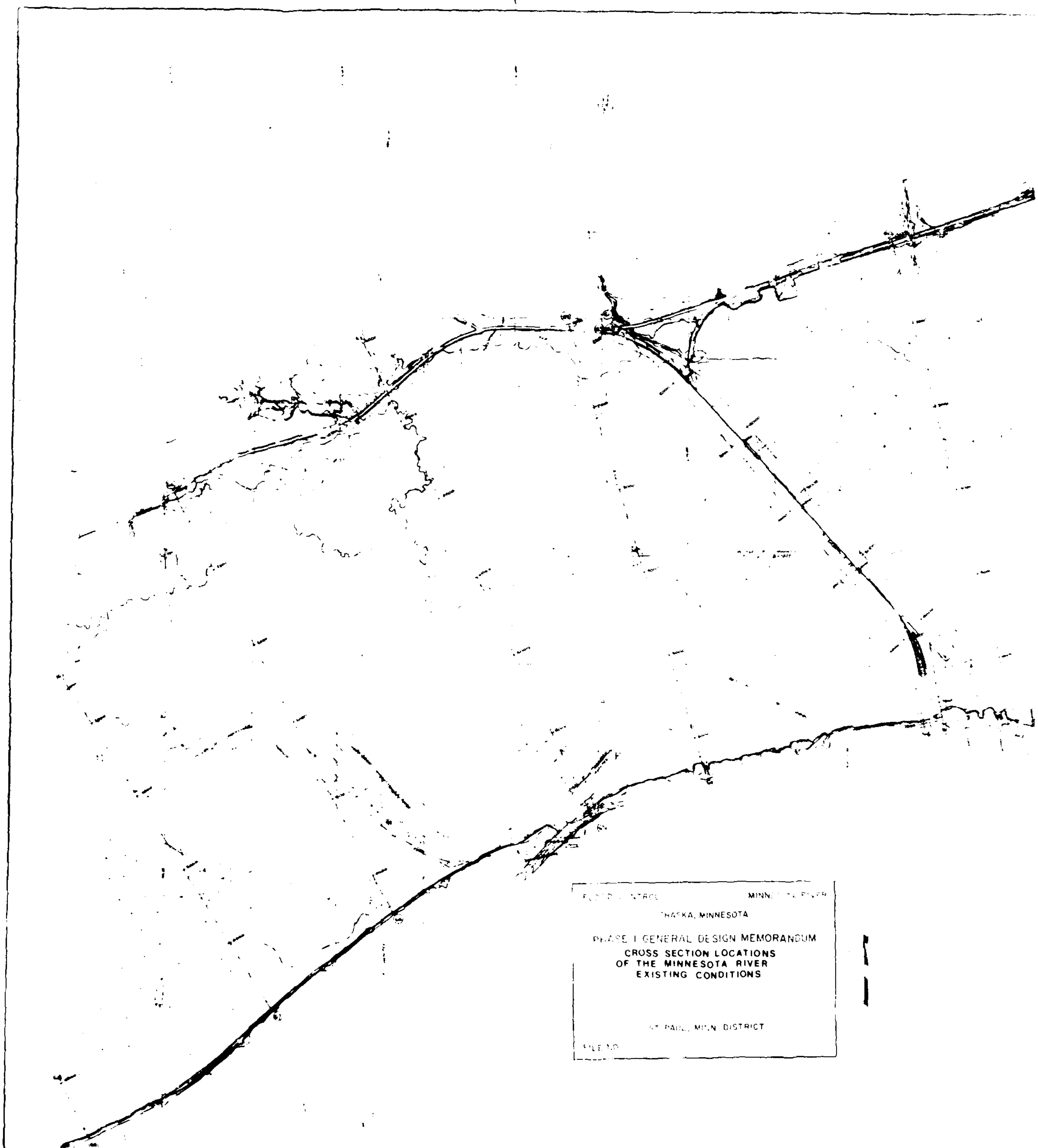


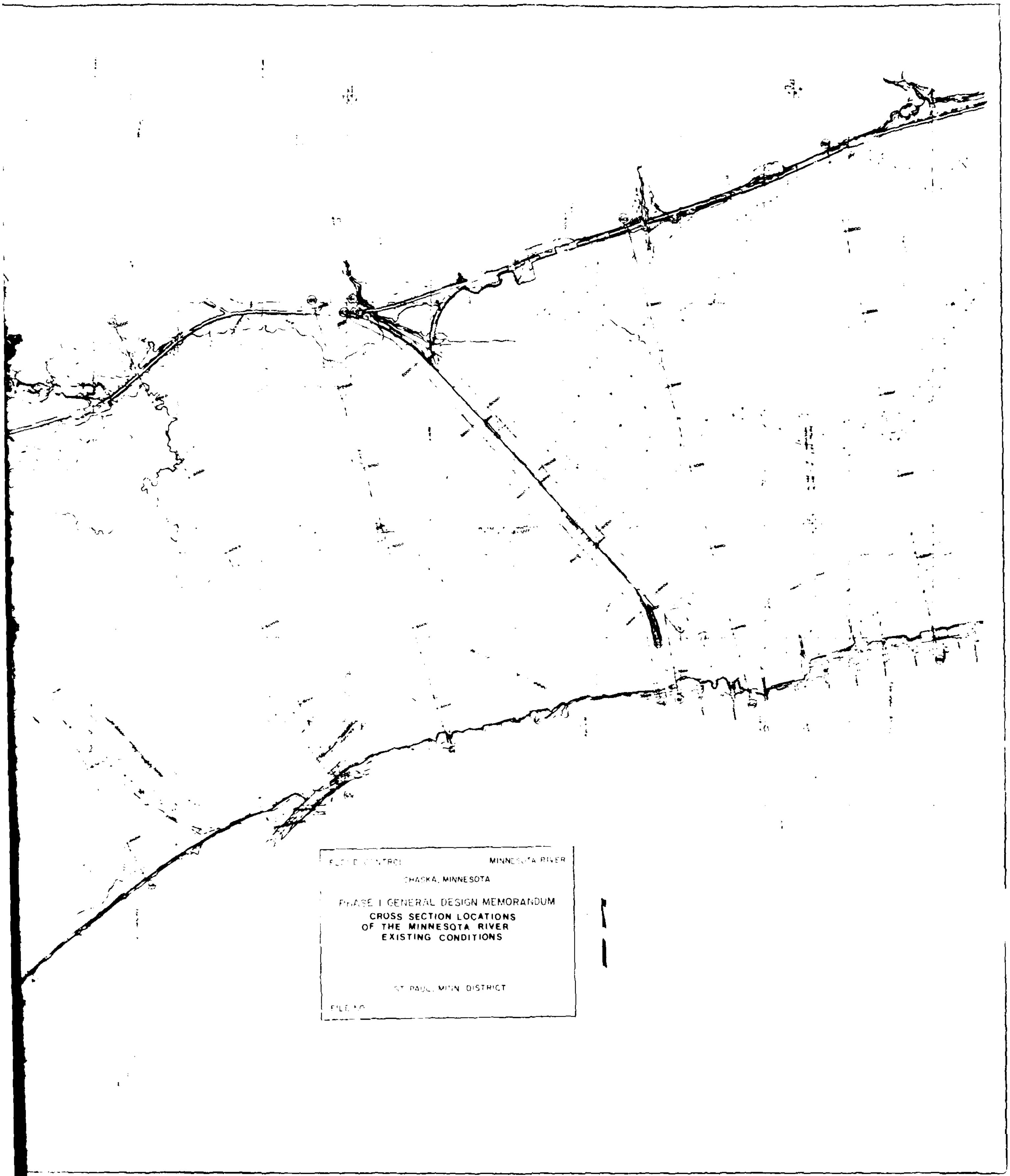
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
EAST CREEK
RESIDUAL FLOOD
COMPUTED WATER SURFACE PROFILES
ST PAUL DISTRICT
ELEVATION IN FEET (1929 NVGD)
RIVER CHANNEL MILEAGE
SPF
1% CHANCE FLOOD
*-DENOTES CROSS SECTION LOCATION
B-DENOTES BRIDGE LOCATION

PLATE 4B-37

APPENDIX 4C

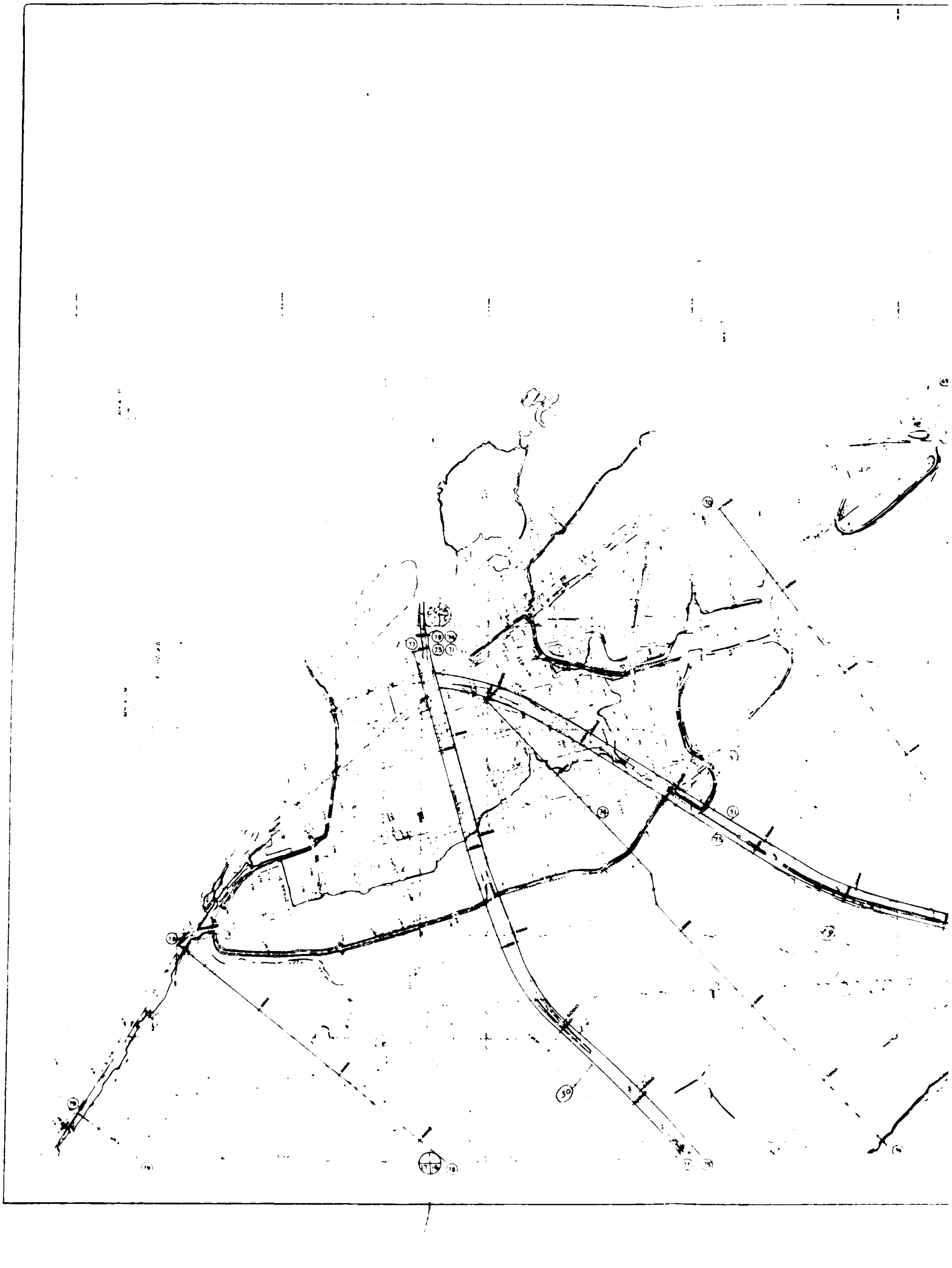
INTERIOR FLOOD CONTROL

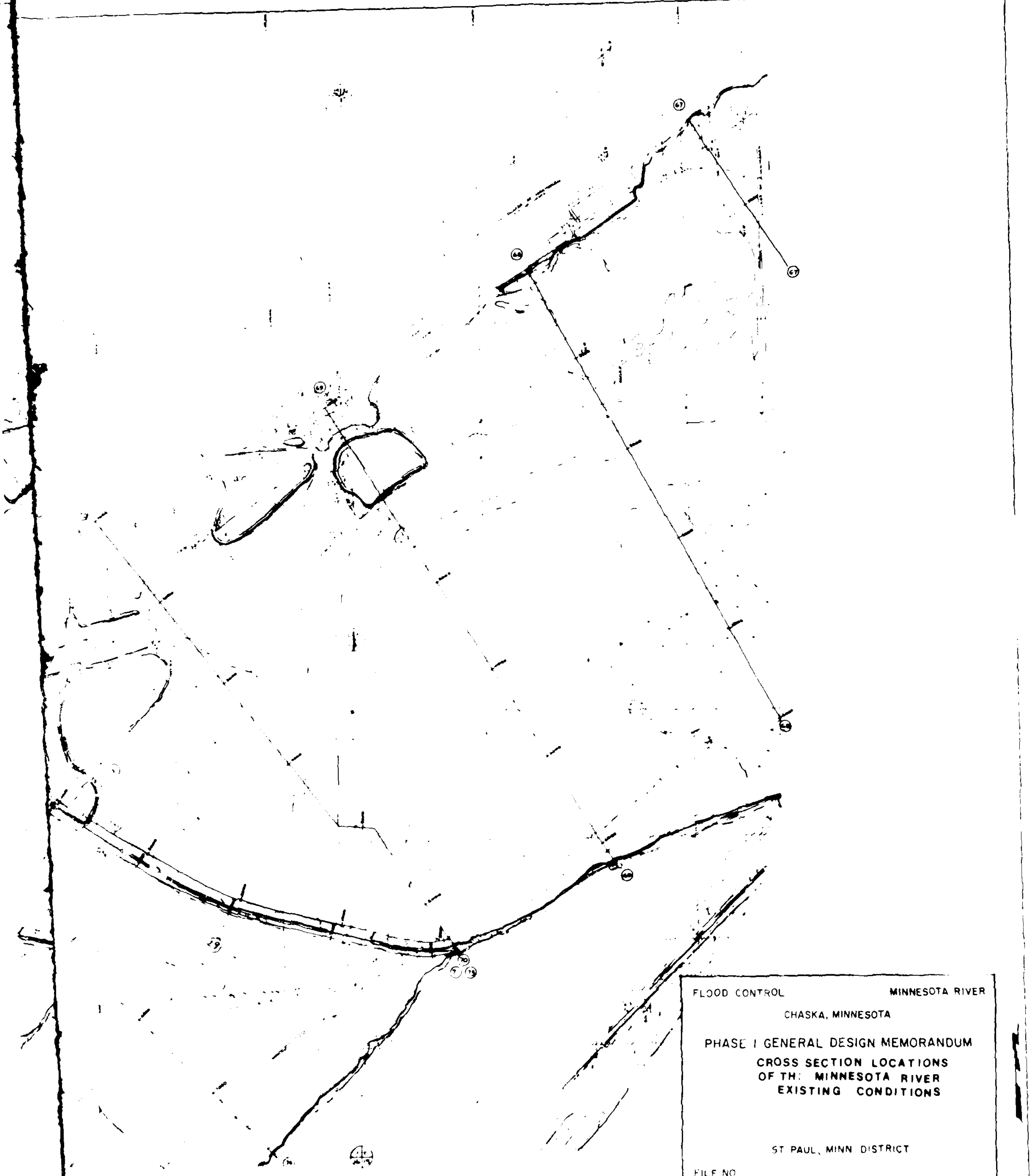

PHASE I GENERAL DESIGN MEMORANDUM
CROSS SECTION LOCATIONS
OF THE MINNESOTA RIVER
EXISTING CONDITIONS



CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
CROSS SECTION LOCATIONS
OF THE MINNESOTA RIVER
EXISTING CONDITIONS
ST PAUL, MINN DISTRICT

PLATE 4B-1





FLOOD CONTROL MINNESOTA RIVER

CHASKA, MINNESOTA

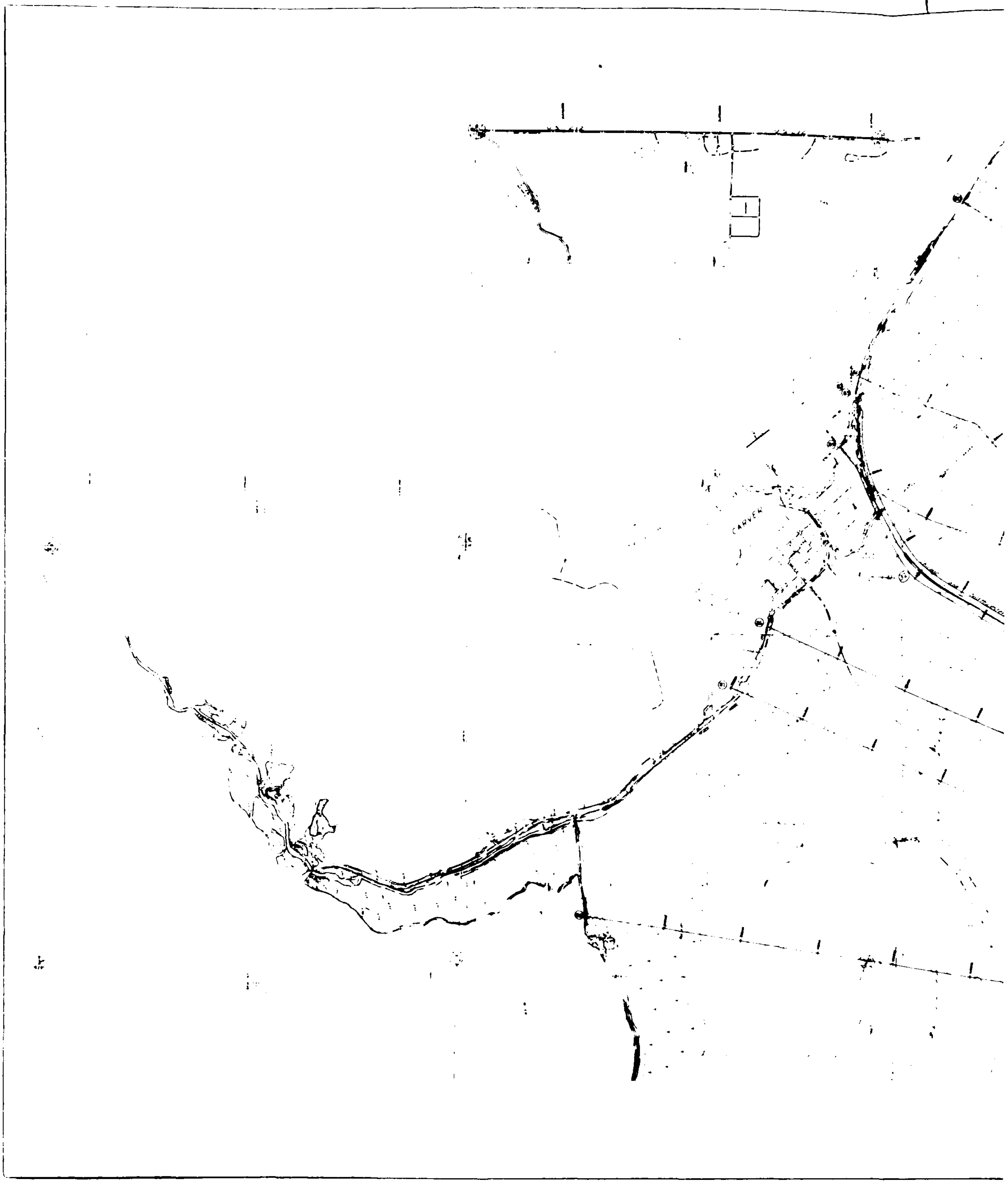
PHASE I GENERAL DESIGN MEMORANDUM

CROSS SECTION LOCATIONS
OF TH: MINNESOTA RIVER
EXISTING CONDITIONS

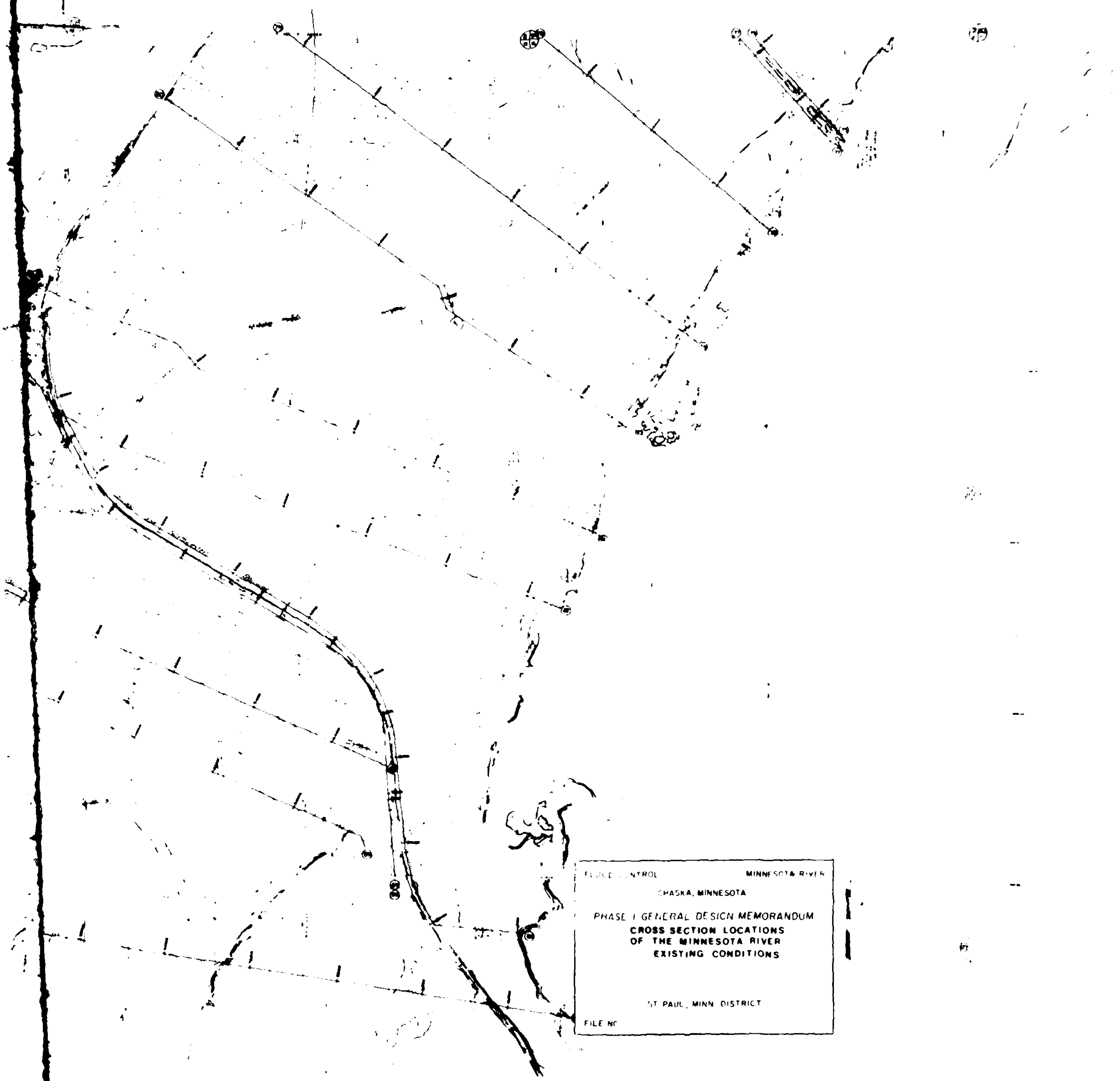
ST PAUL, MINN DISTRICT

FILE NO

PLATE 4B-2



CARVER



FLOOD CONTROL MINNESOTA RIVER

CHASKA, MINNESOTA

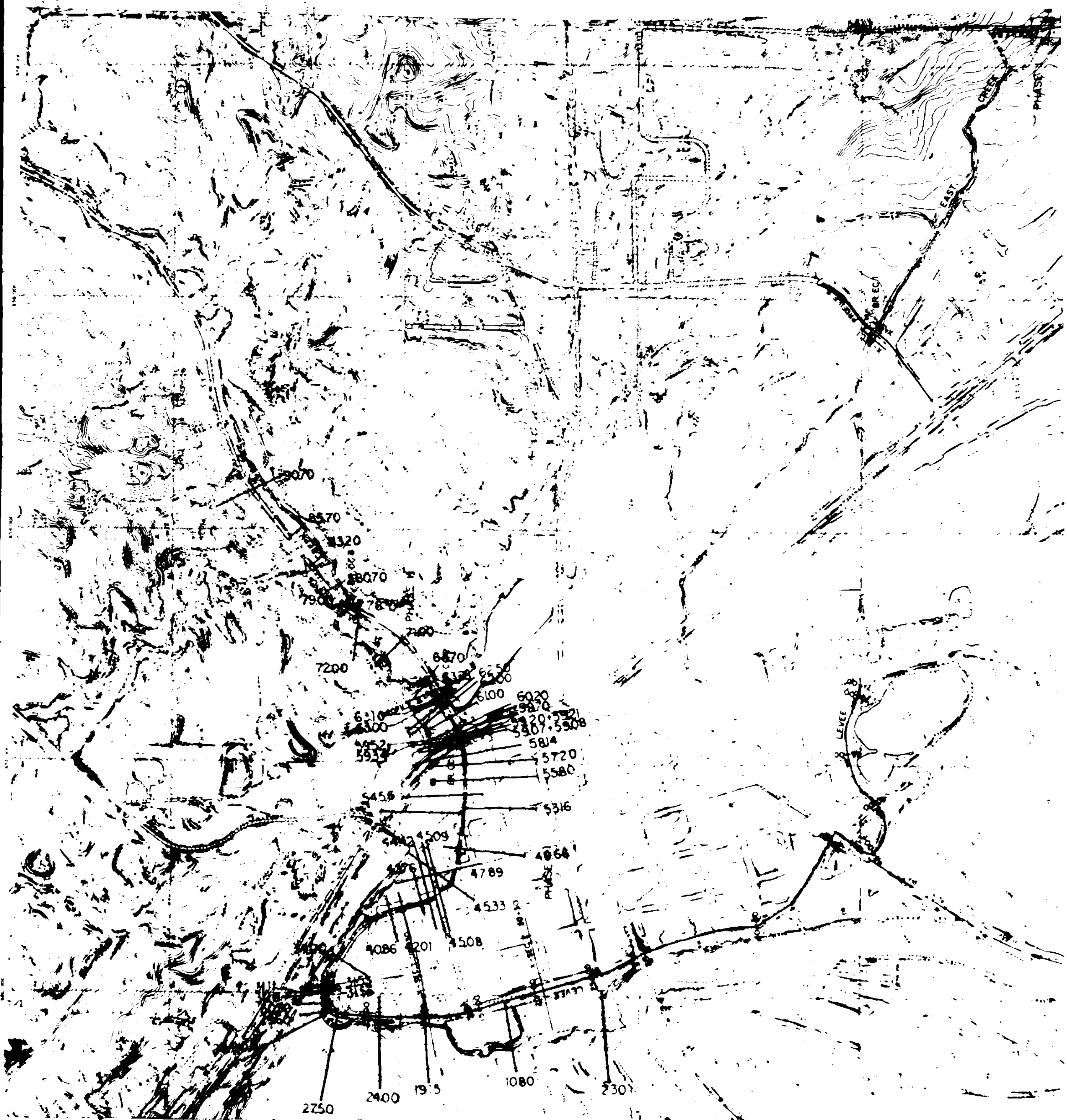
PHASE I GENERAL DESIGN MEMORANDUM

CROSS SECTION LOCATIONS OF THE MINNESOTA RIVER EXISTING CONDITIONS

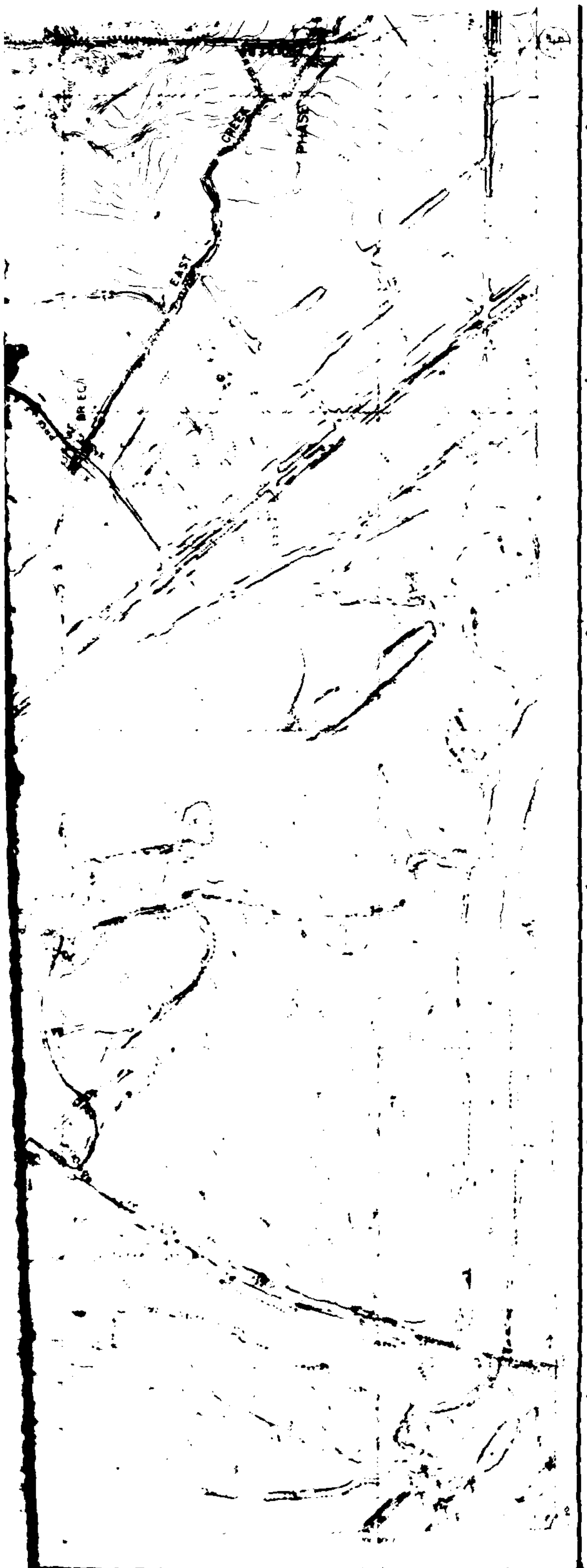
ST PAUL, MINN. DISTRICT

FILE NO

PLATE 4B-3



9070
8570
8320
8070
7900
7200
6870
6100
6020
5814
5720
5580
5456
5316
4964
4789
4533
4508
4201
4086
2750
2400
1080
230
LEVEE
LEVEE
PHASE
EAST
CREEK



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

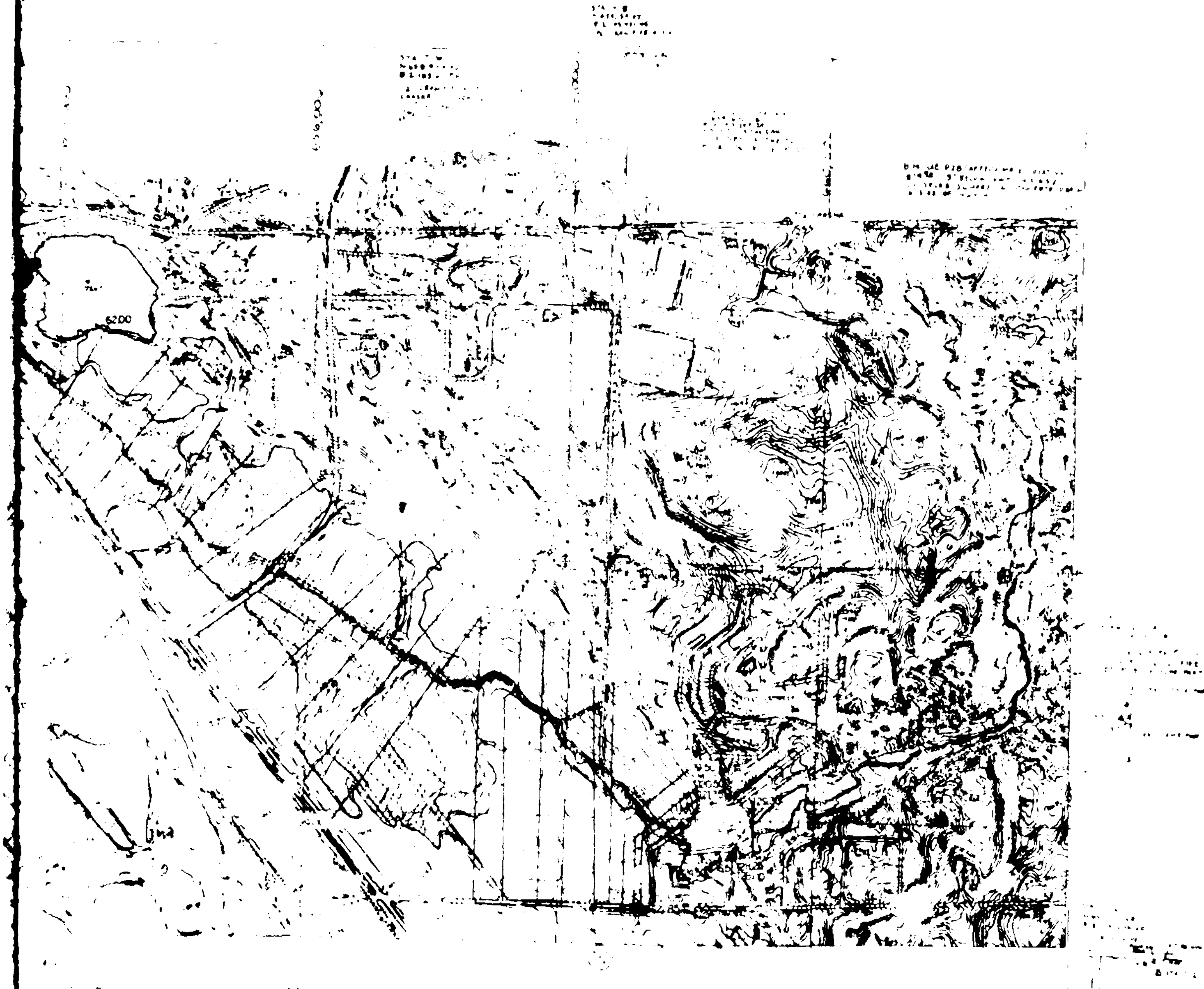
CROSS SECTION LOCATIONS OF CHASKA CREEK

EXISTING CONDITIONS

ST. PAUL DISTRICT

PLATE 4B-9

NOTE



SHEET INDEX

AND THE MINNESOTA RIVER AT CHASKA MINNESOTA

RESIDUAL

APPR

STAN PROJECT FLOOD OUTLINE

FLOOD CONTROL — MINNESOTA RIVER

CHASKA MINNESOTA

PHASE GENERAL DESIGN MEMORANDUM

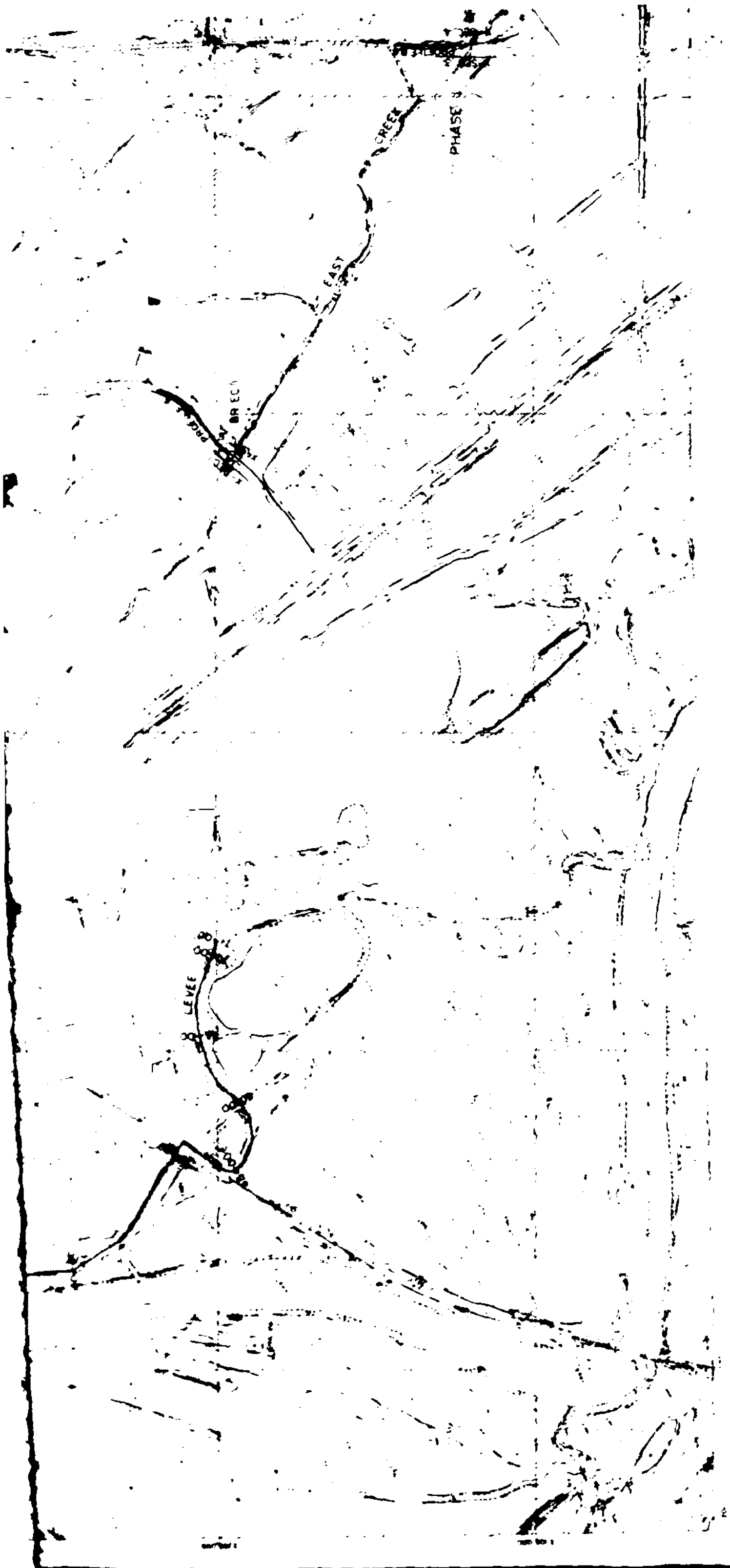
EAST CREEK

RESIDUAL FLOOD PLAIN THE

1% CHANCE & STANDARD PROJECT FLOOD

WITHOUT PROJECT CONDITIONS

CREEK
EAST
LEVEE



1. For East Creek Phase I See Drawings M14 [illegible] thru M14 [illegible]
2. For [illegible] Creek Phase II See Drawing M14 [illegible]
3. For Levees Phase II, See Drawings M14 [illegible] thru M14 [illegible]
4. For [illegible] Photos See Book M14 [illegible]
5. For Field Notes See Book M14 [illegible]
6. Vertical Datum NGVD 1929 Adj.

SCALE IN FEET

0 200 400 800

FLOOD CONTROL MINNESOTA RIVER

CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

OVERBANK CROSS SECTION LOCATIONS OF CHASKA CREEK

EXISTING CONDITIONS

ST. PAUL DISTRICT

POND ELEVATIONS FOR WITHOUT PROJ. COND. – NGVD OF 1929

	ONE PERCENT CHANCE OF FLOOD	0.2 PERCENT CHANCE OF FLOOD
EXISTING	719.0	721.6
FUTURE	721.5	721.8

1. For East Creek Phase I See ...
2. For Chaska Creek Phase II See ...
3. For Levees Phase III See ...
4. For Structure Photo ... See ...
5. For Field Notes See ...
6. Vertical Datum ...

SAFETY PAYS

SYMBOL	DESCRIPTION	DATE	APPROVAL

John W. Gorman, Inc.

DEPARTMENT OF THE ARMY

DESIGNED BY

DRAWN BY R.W.C.

CHECKED BY

SUBMITTED BY

APPROVED

MINNESOTA RIVER

CHASKA, MINNESOTA

PHASE ... GENERAL DESIGN MEMORANDUM

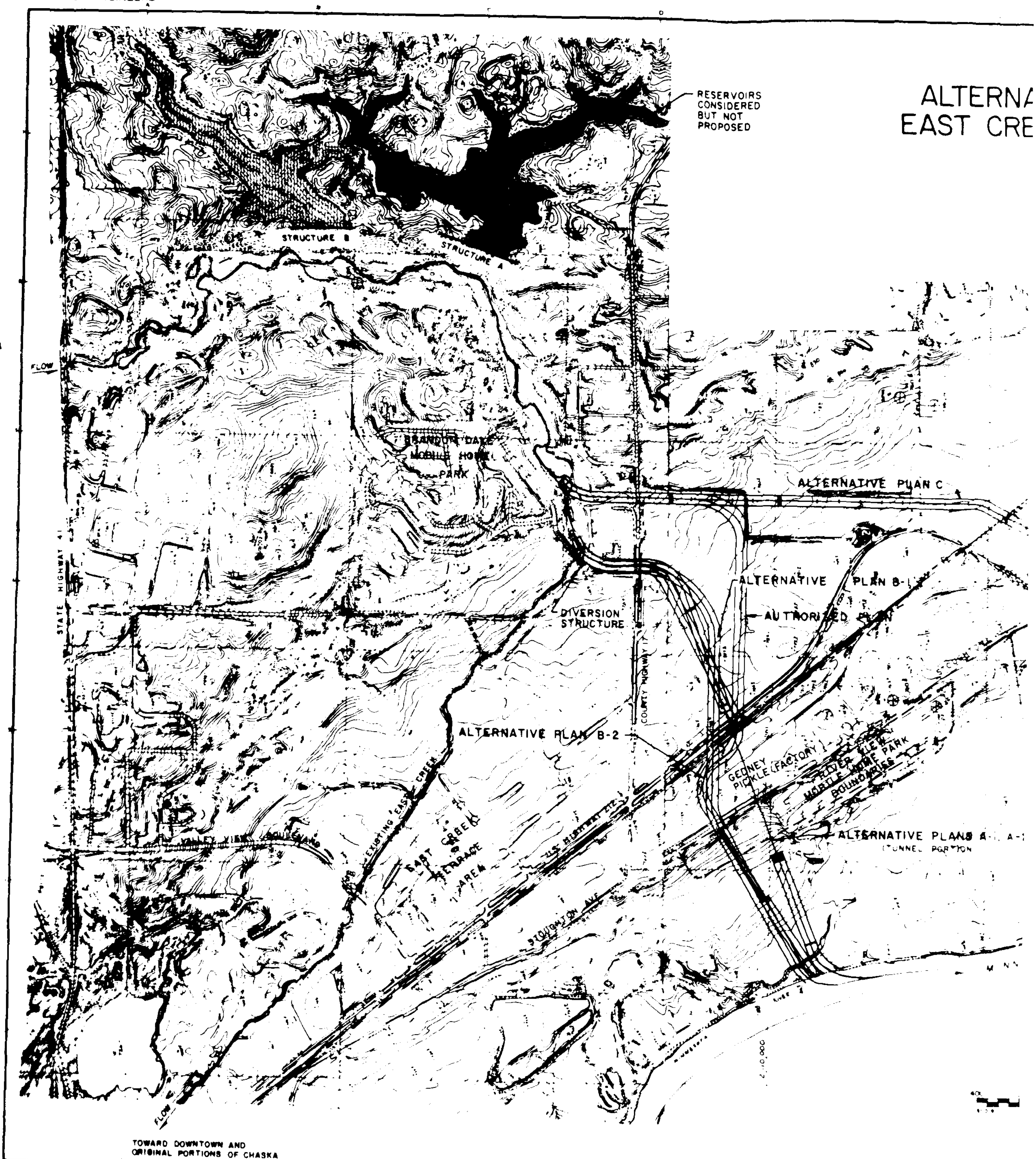
PONDING AREA LOCATION

CHASKA CREEK

ST. PAUL, MINN. DISTRICT

PLATE 4B-28

CORPS OF ENGINEERS

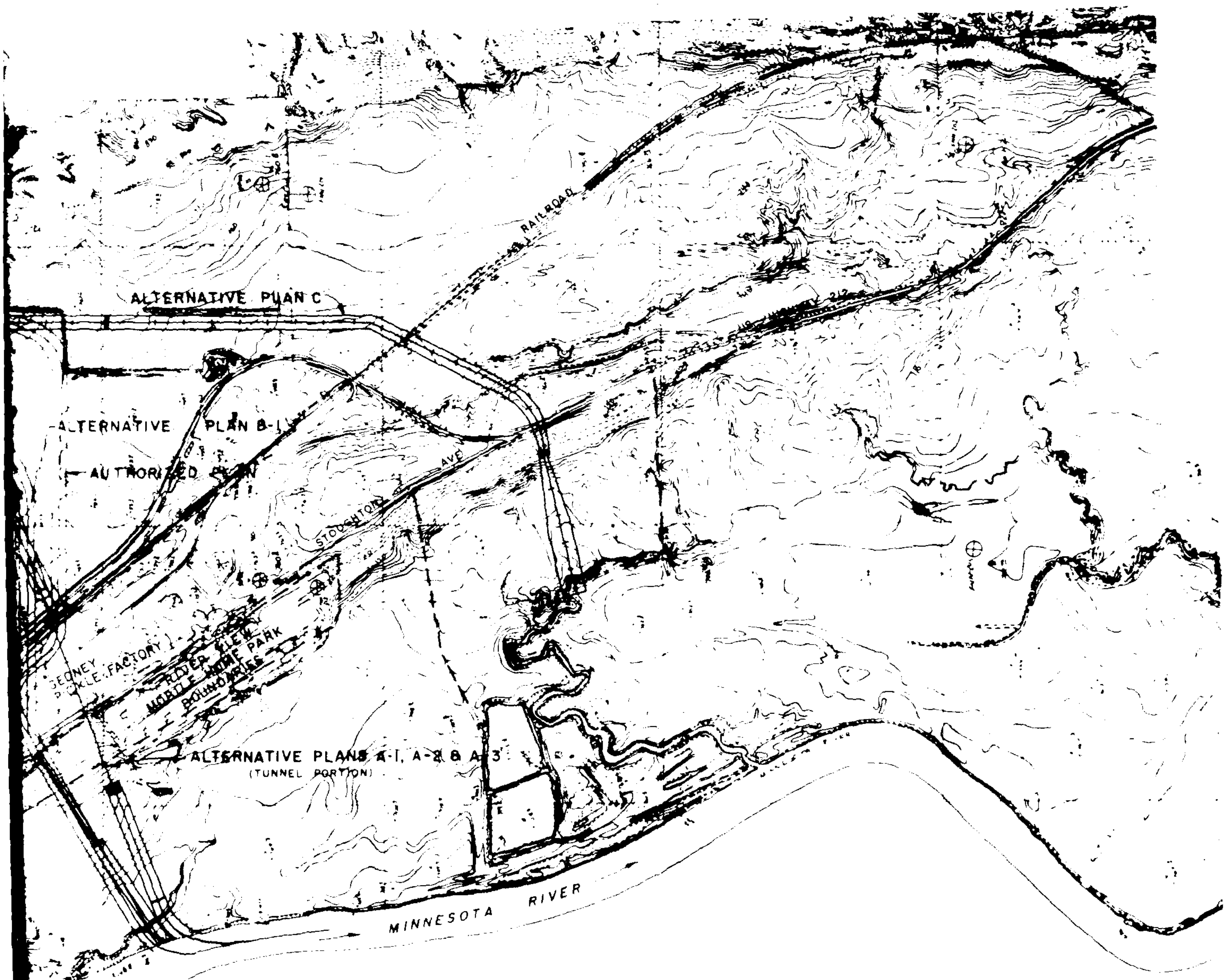


TOWARD DOWNTOWN AND ORIGINAL PORTIONS OF CHASKA

U S ARM

ESERVOIRS
ONSIDERED
UT NOT
ROPOSED

ALTERNATIVE DESIGNS
EAST CREEK DIVERSION



IN 3 SHEETS SHEET NO

PHASE I GENERAL DESIGN MEMORANDUM

ST. PAUL DISTRICT CORPS OF ENGINEERS

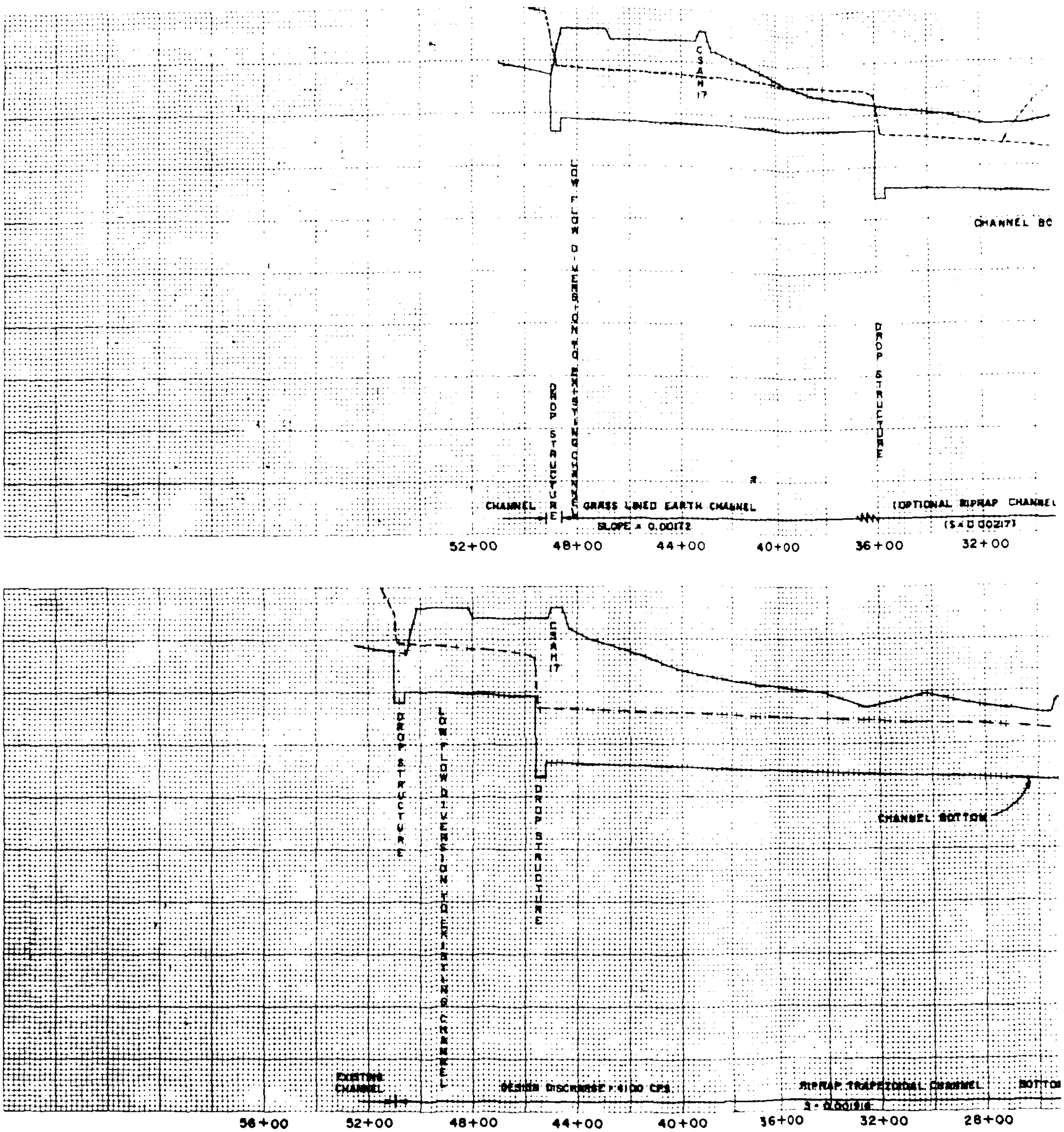
SUBMITTED RECOMMENDED APPROVED

CHIEF ENGINEERING DIV. COL. CORPS OF ENGINEERS

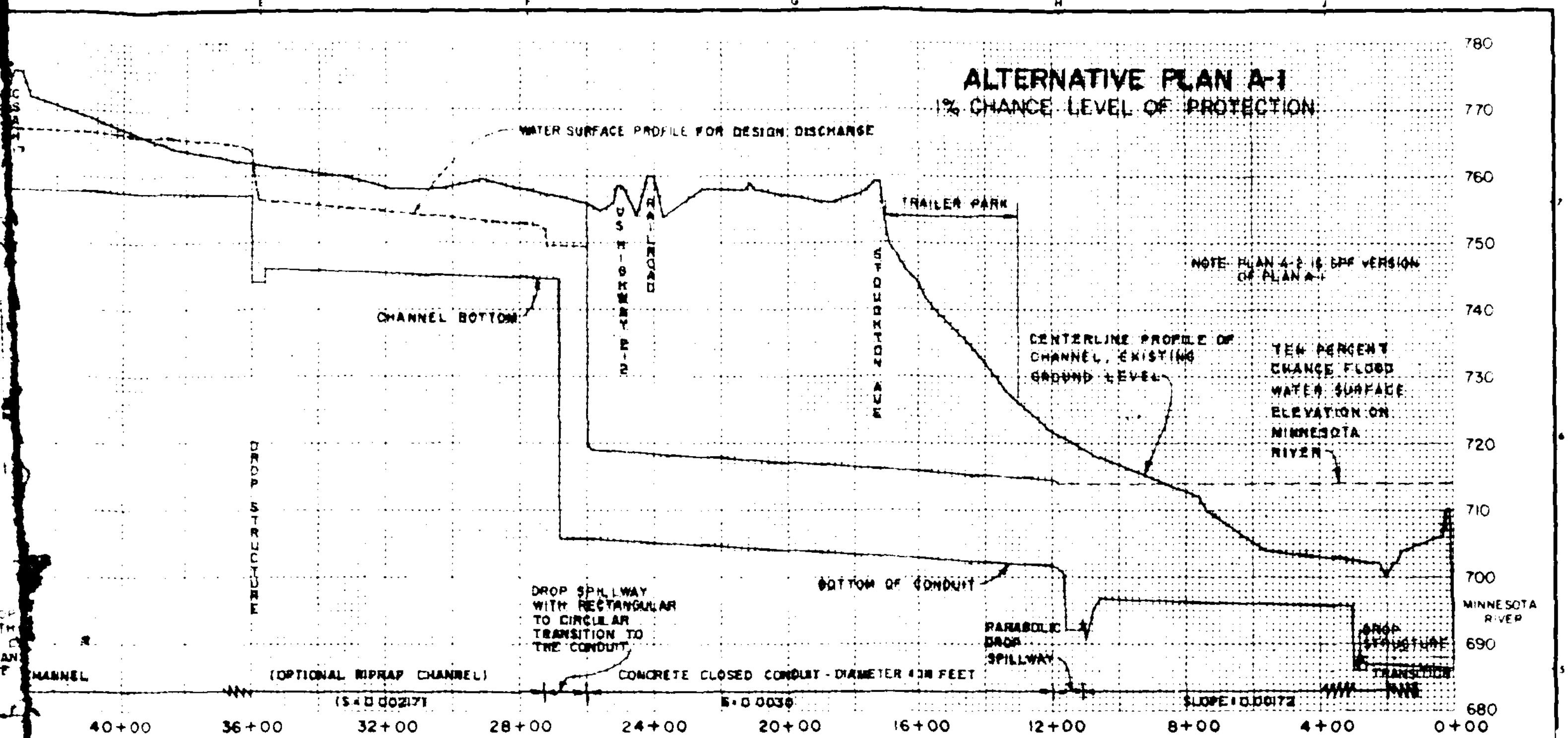
DRAWN BY FILE NO TRANSMITTED WITH REPORT

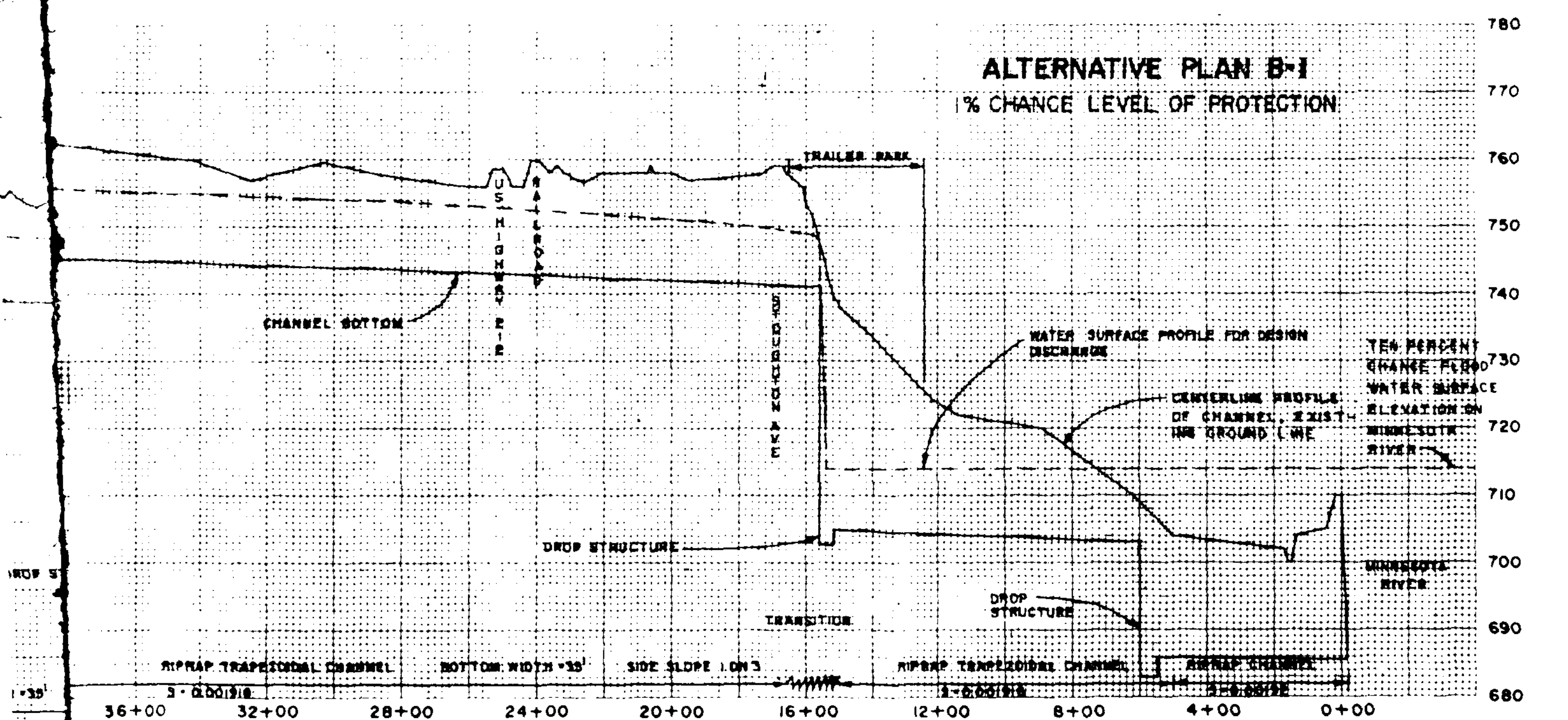
CHECKED BY M34-CH-R-5/84 DATED

PLATE 4B-38



ALTERNATIVE DESIGNS
EAST CREEK DIVERSION





IVE DESIGNS
EK DIVERSION

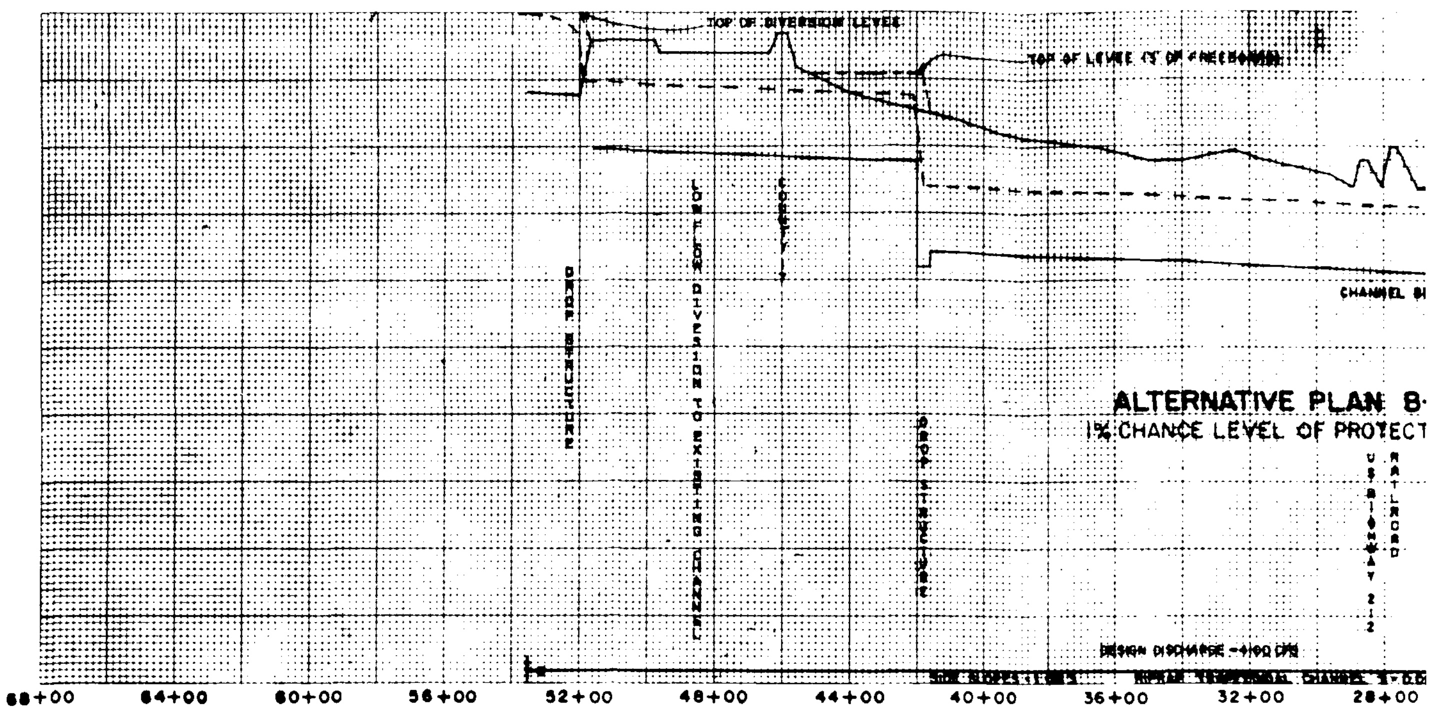
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

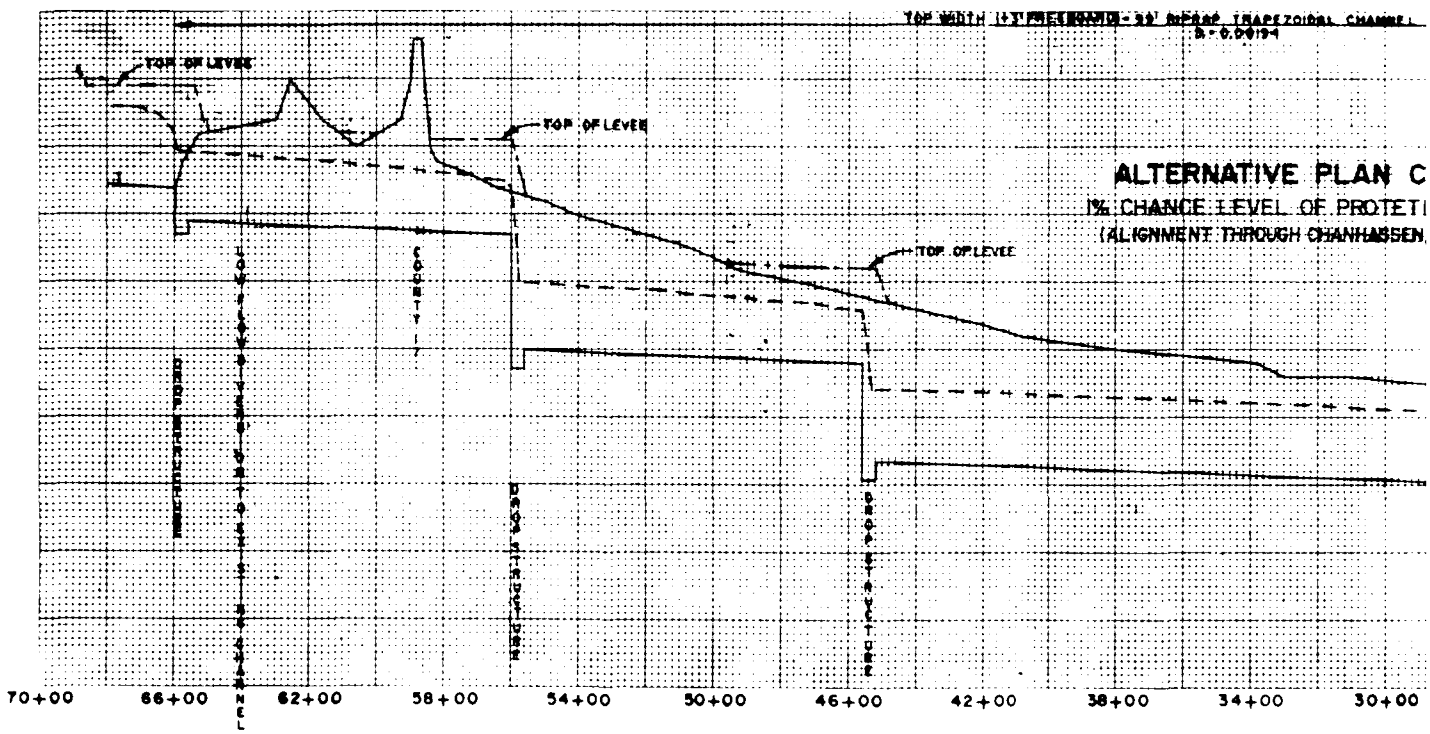
GENERAL DESIGN MEMORANDUM — PHASE I
CHASKA, MINNESOTA
EAST CREEK
PRELIMINARY DESIGN

SUBMITTED BY
APPROVED
DATE

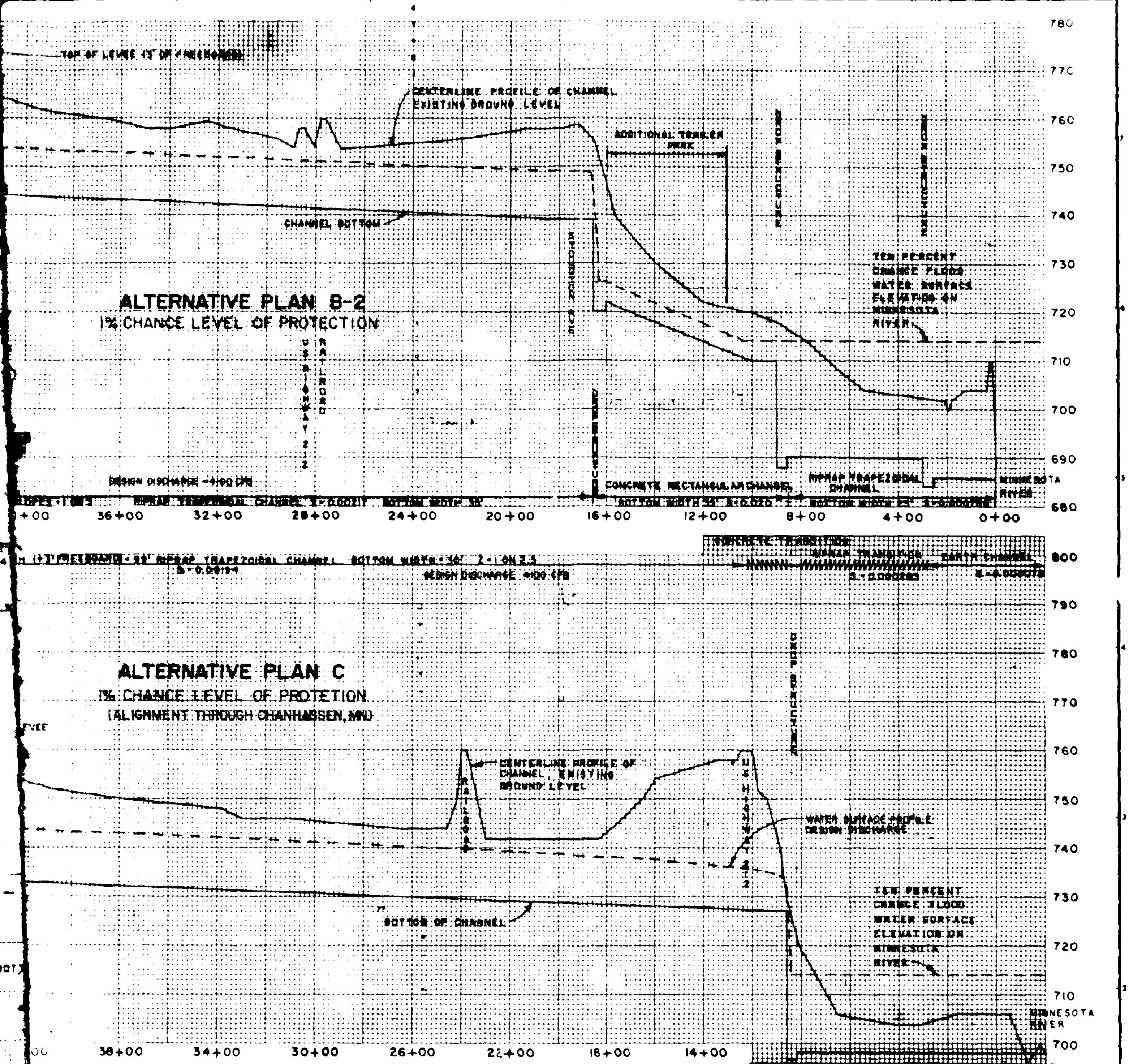
DRAWING NUMBER
M34-CH-R-5/25
SHEET 2 OF 3

PLATE 4B-39





ALTERNATIVE DESIGNS
EAST CREEK DIVERSION



TERNATIVE DESIGNS
T CREEK DIVERSION

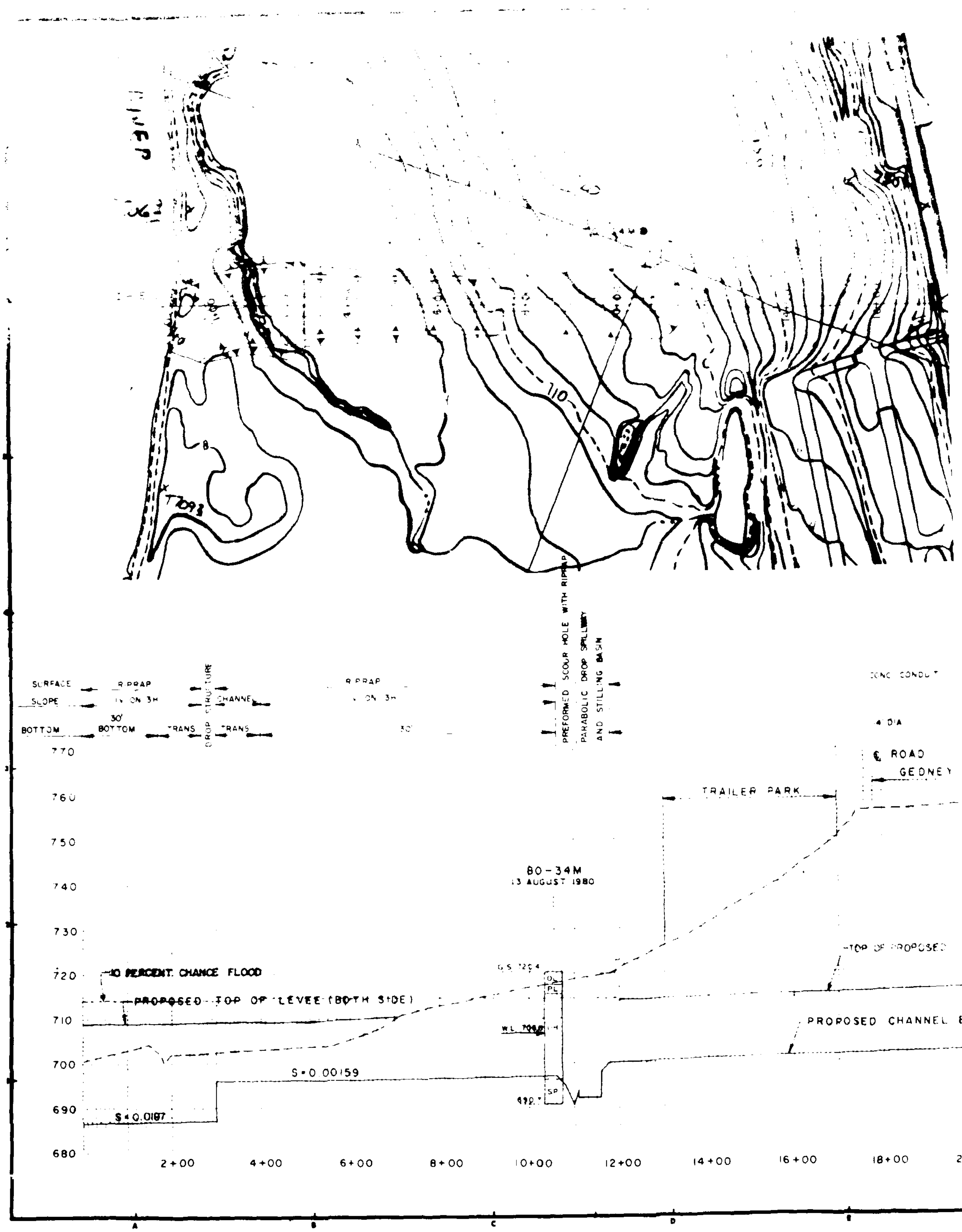
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

GENERAL DESIGN MEMORANDUM PHASE I
CHASKA, MINNESOTA
EAST CREEK
PRELIMINARY DESIGN

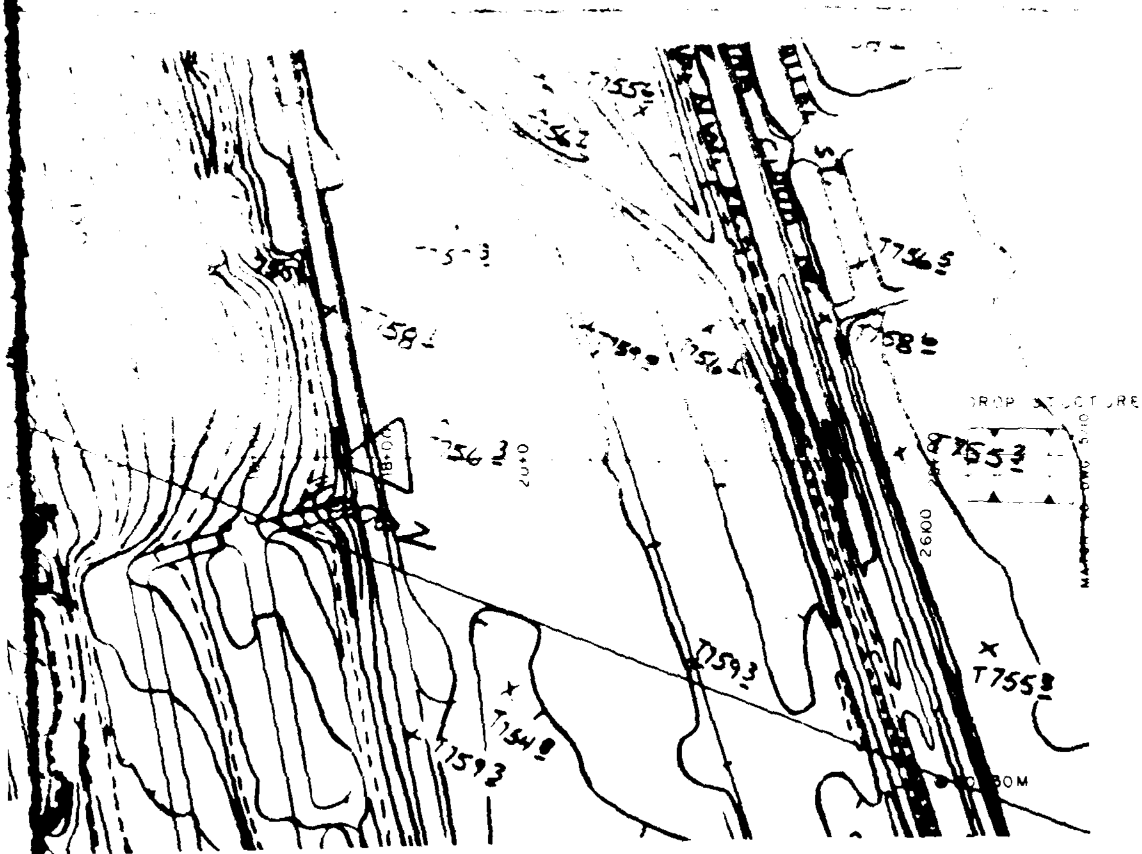
SUBMITTED BY
APPROVED
DATE

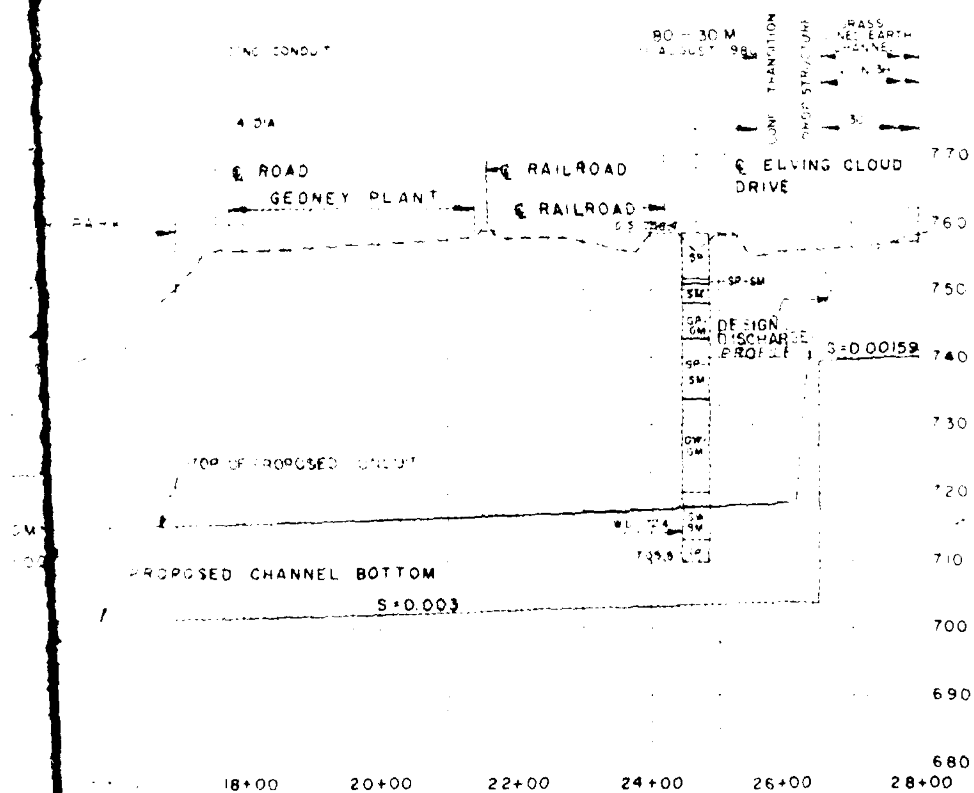
DRAWING NUMBER
M34-CH-R-5/26

PLATE 4B-40



110
SURFACE
SLOPE
BOTTOM
RIPRAP
1V ON 3H
30' BOTTOM
TRANS
DROP STRUCTURE
CHANNEL
TRANS
PREFORMED SCOUR HOLE WITH RIPRAP
PARABOLIC DROP SPILLWAY AND STILLING BASIN
CONC CONDUIT
4' DIA
℄ ROAD
GEDNEY
TRAILER PARK
80-34M
13 AUGUST 1980
10 PERCENT CHANCE FLOOD
PROPOSED TOP OF LEVEE (BOTH SIDE)
TOP OF PROPOSED
PROPOSED CHANNEL
S=0.00159
S=0.0187
770
760
750
740
730
720
710
700
690
680
2+00
4+00
6+00
8+00
10+00
12+00
14+00
16+00
18+00
A
B
C
D
E





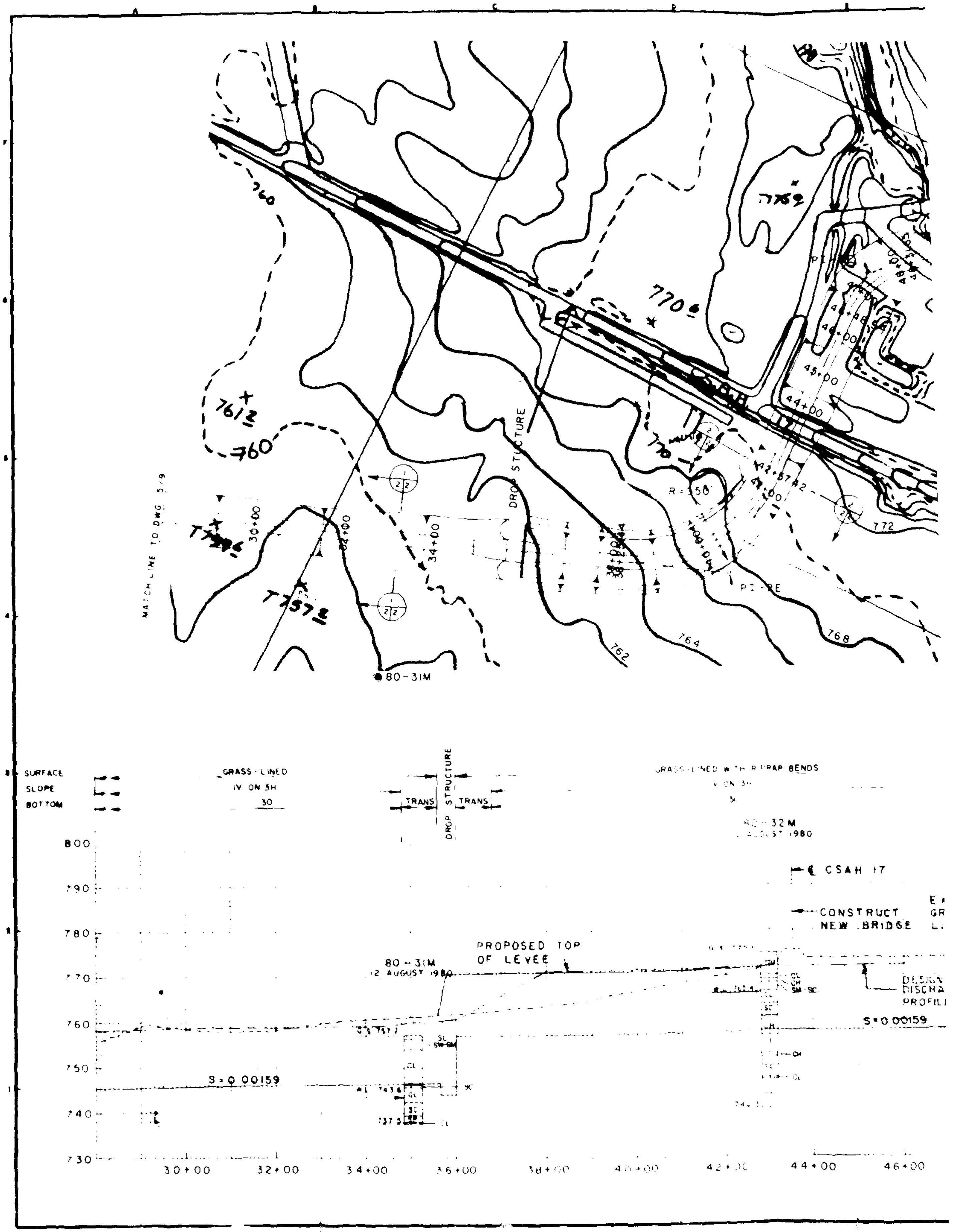
SUBMITTED BY

APPROVED

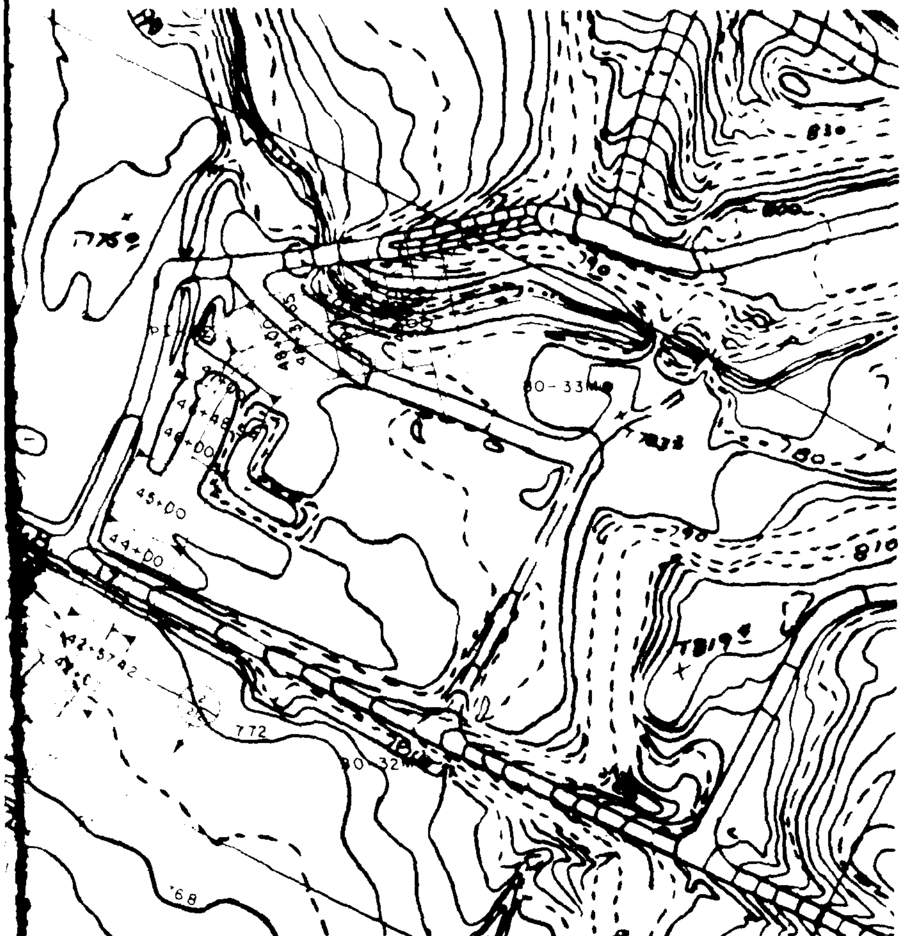
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
EAST CREEK DIVERSION
PLAN, PROFILE, AND BORINGS
STA 0+00 TO 28+00

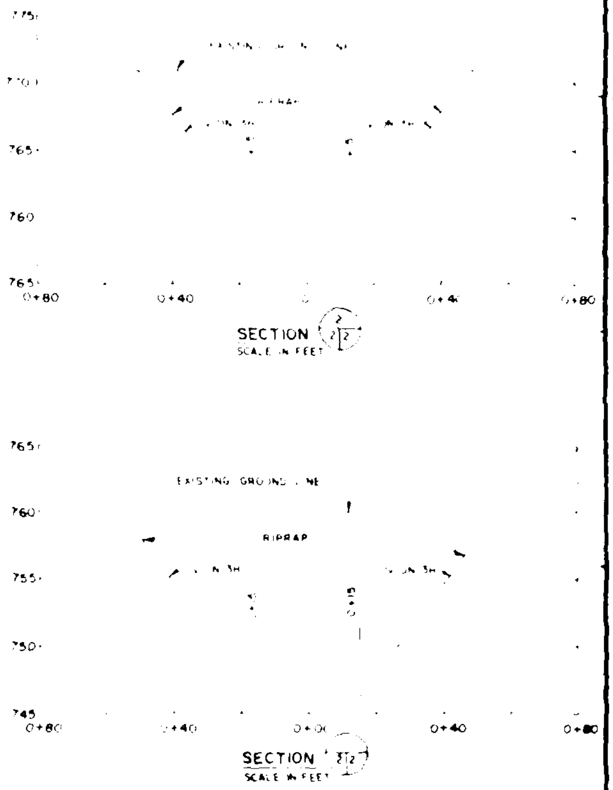
DATE:

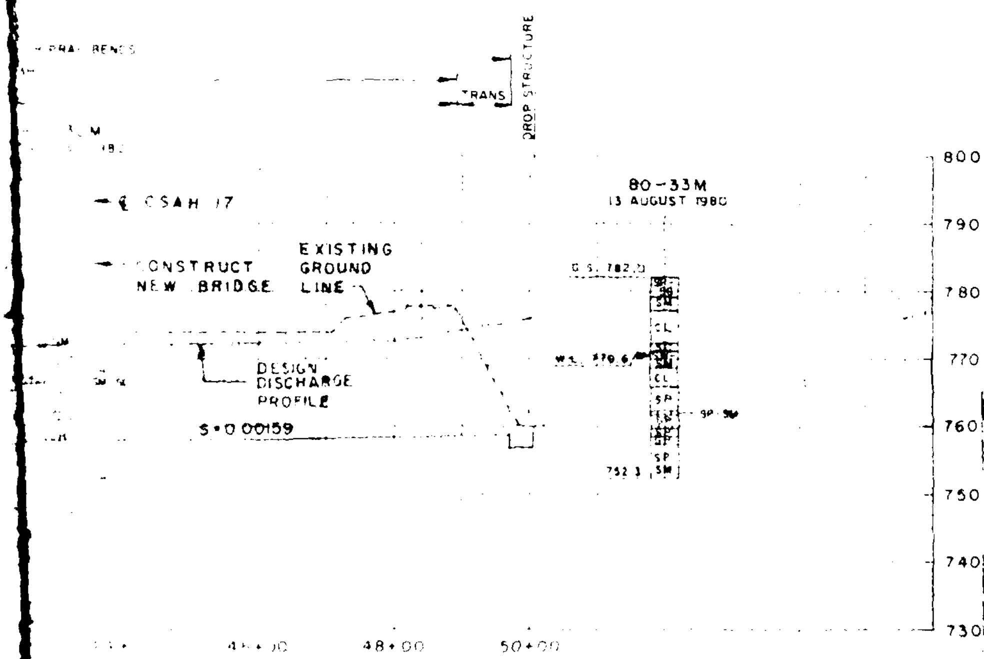
DRAWING NUMBER
M34-CH-R-5/9



MATCH LINE TO DWG. 5/9
760
761±
772±
775±
770±
775±
DROP STRUCTURE
30+00
32+00
34+00
38+00
40+00
44+00
45+00
46+00
R=350
PI
762
764
768
772
80-31M
SURFACE
SLOPE
BOTTOM
GRASS-LINED
1V ON 3H
30
TRANS
DROP STRUCTURE
GRASS-LINED WITH RIPRAP BENDS
80-32M
CSAH 17
CONSTRUCT
NEW BRIDGE
PROPOSED TOP
OF LEVEE
80-31M
12 AUGUST 1980
S=0.00159
S=0 00159
800
790
780
770
760
750
740
730
30+00
32+00
34+00
36+00
38+00
40+00
42+00
44+00
46+00







FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

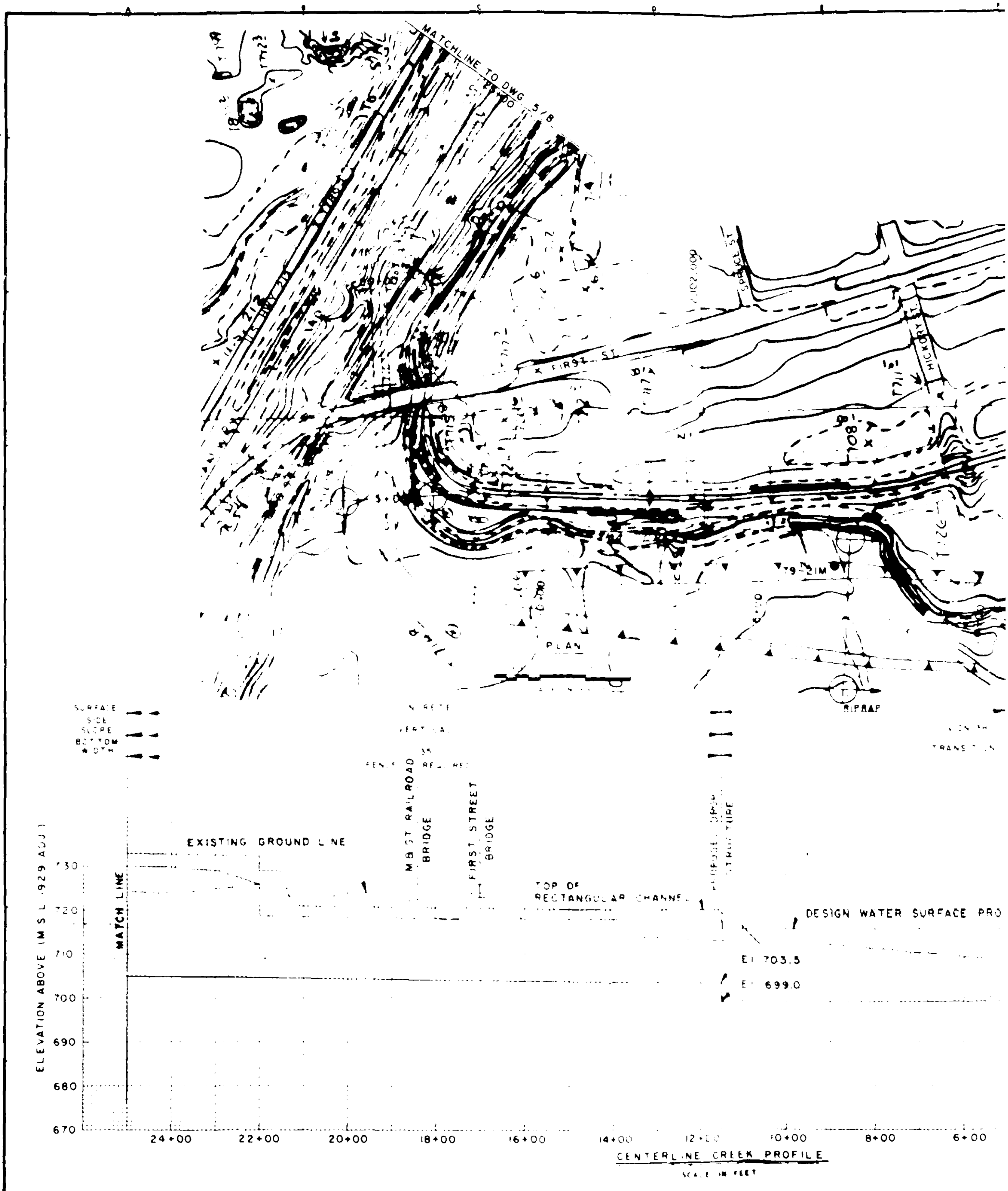
PHASE I GENERAL DESIGN MEMORANDUM

EAST CREEK DIVERSION

PLAN, PROFILE, AND BORINGS

STA. 30+00 TO 50+00

ST PAUL DISTRICT


MATCHLINE TO DWG 5/8
U.S. HWY 218
FIRST ST
SPRUCE ST
HICKORY ST
PLAN
RIPRAP
EXISTING GROUND LINE
M & ST RAILROAD BRIDGE
FIRST STREET BRIDGE
TOP OF RECTANGULAR CHANNEL
DESIGN WATER SURFACE PRO
EL 703.5
EL 699.0
MATCH LINE
ELEVATION ABOVE (M S L 1929 ADJ)
730
720
710
700
690
680
670
24+00
22+00
20+00
18+00
16+00
14+00
12+00
10+00
8+00
6+00
CENTERLINE CREEK PROFILE
SCALE IN FEET

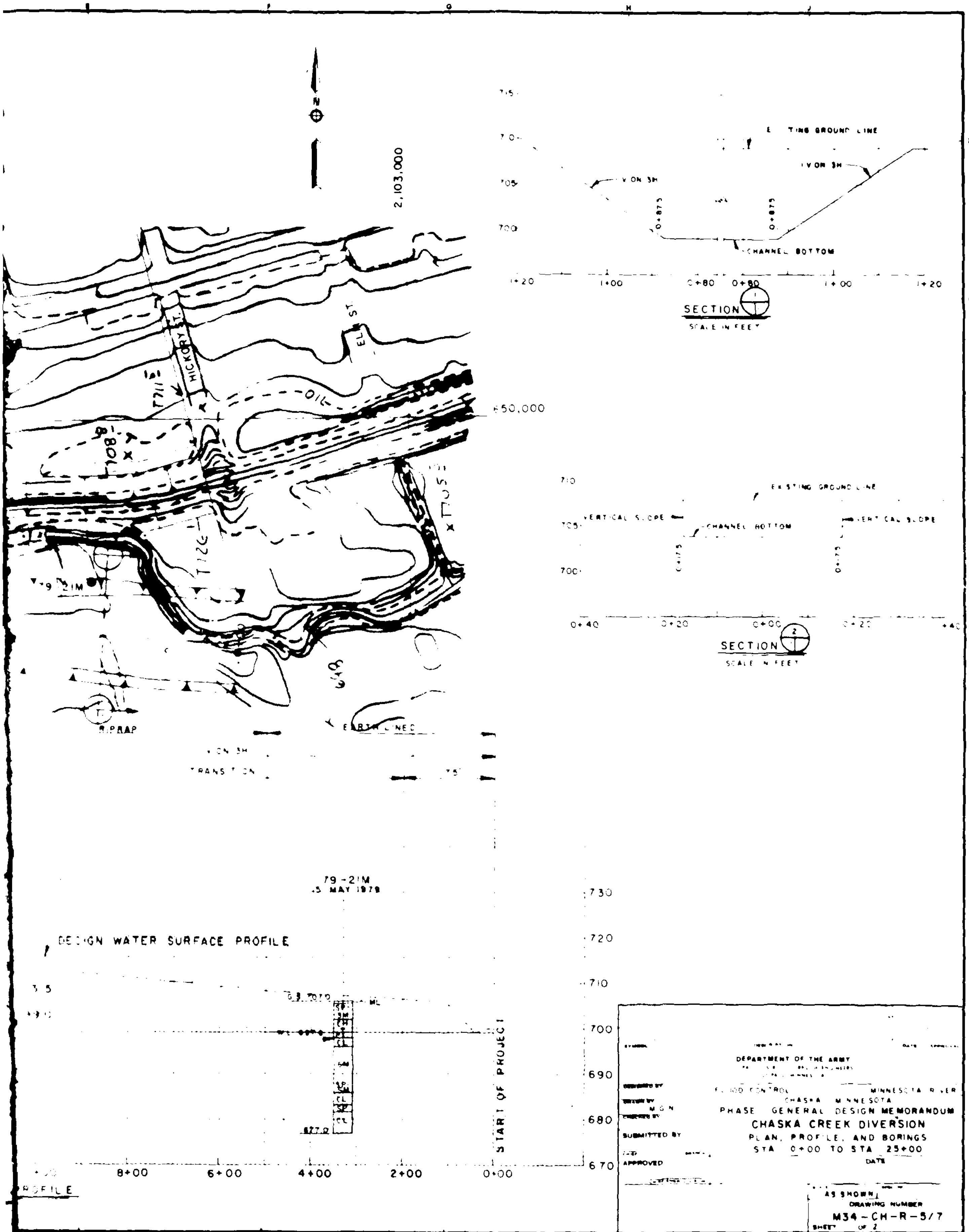
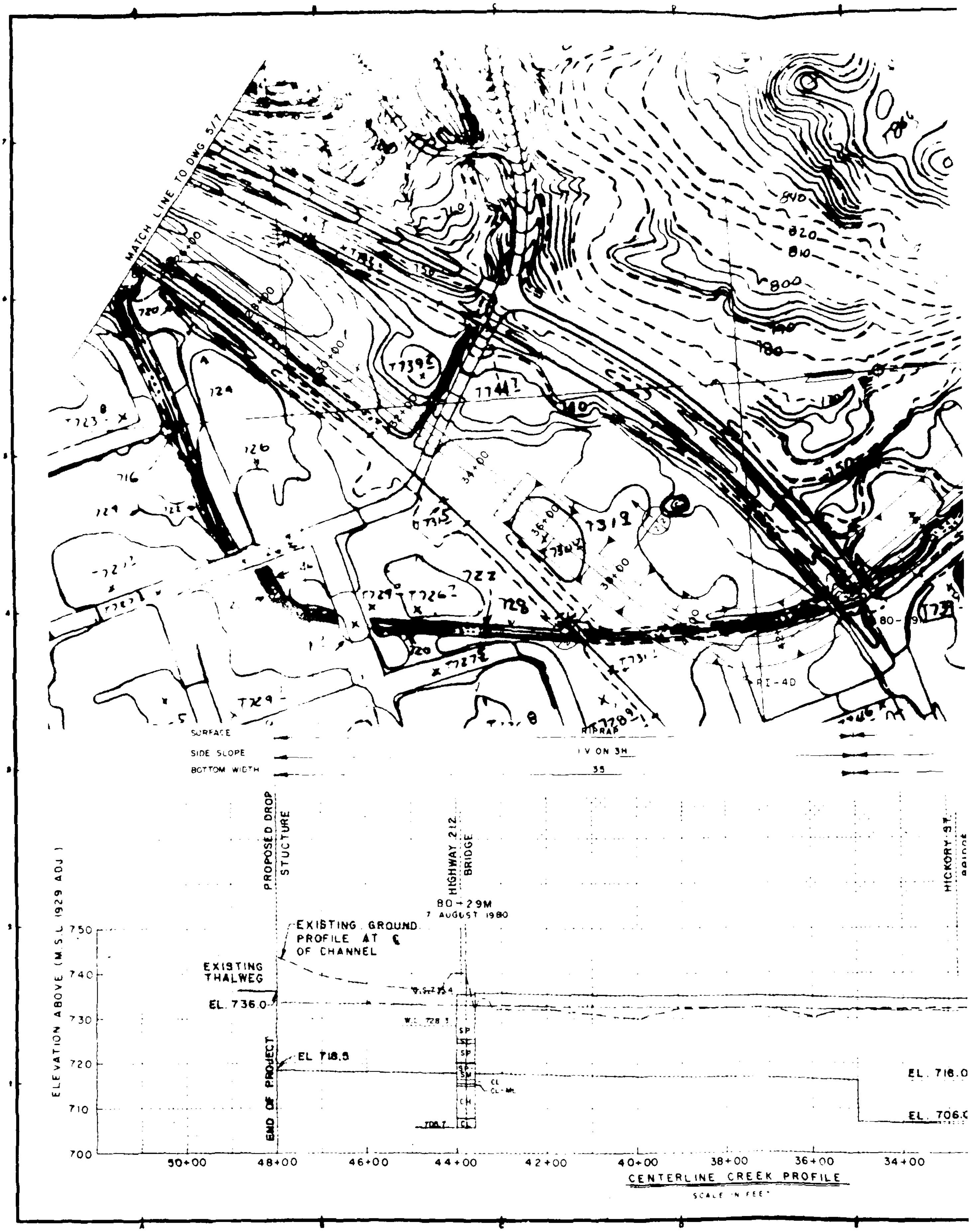
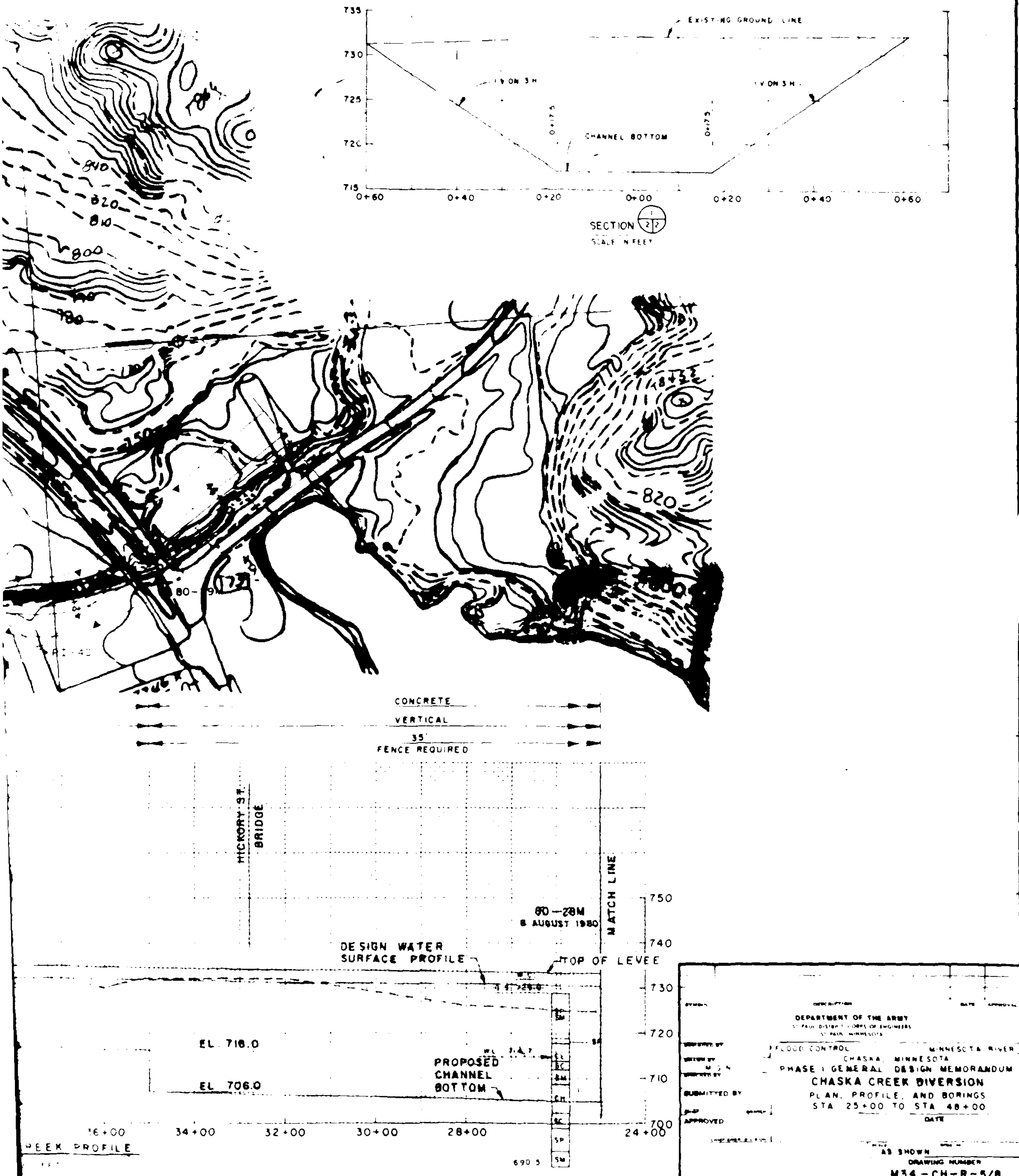

2,103,000
650,000
HICKORY ST.
ELM ST.
OIL
RIPRAP
EARTH LINED
TRANSITION
EXISTING GROUND LINE
CHANNEL BOTTOM
SECTION 1
SCALE IN FEET
EXISTING GROUND LINE
VERTICAL SLOPE
CHANNEL BOTTOM
SECTION 2
SCALE IN FEET
79-21M
5 MAY 1979
DESIGN WATER SURFACE PROFILE
START OF PROJECT
8+00
6+00
4+00
2+00
0+00
730
720
710
700
690
680
670
PROFILE
DEPARTMENT OF THE ARMY
FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
CHASKA CREEK DIVERSION
PLAN, PROFILE, AND BORINGS
STA 0+00 TO STA 25+00
SUBMITTED BY
APPROVED
AS SHOWN
DRAWING NUMBER
M34-CH-R-5/7

PLATE 48-43



MATCH LINE TO DWG 5/7
RIPRAP
RI-40
SURFACE
SIDE SLOPE
BOTTOM WIDTH
1 V ON 3H
35
PROPOSED DROP STUCTURE
HIGHWAY 212 BRIDGE
HICKORY ST. BRIDGE
80-29M
7 AUGUST 1980
EXISTING GROUND PROFILE AT ℄ OF CHANNEL
EXISTING THALWEG
EL. 736.0
EL. 718.5
EL. 718.0
EL. 706.0
END OF PROJECT
ELEVATION ABOVE (M.S.L 1929 ADJ.)
750
740
730
720
710
700
W.S. 735.4
W.L. 728.5
SP
SM
CL
CL-ML
CH
706.7
50+00
48+00
46+00
44+00
42+00
40+00
38+00
36+00
34+00
CENTERLINE CREEK PROFILE
SCALE IN FEET



DEPARTMENT OF THE ARMY

FLOOD CONTROL — MINNESOTA RIVER

CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

CHASKA CREEK DIVERSION

PLAN, PROFILE, AND BORINGS

STA 25+00 TO STA 48+00

SUBMITTED BY

APPROVED

DATE

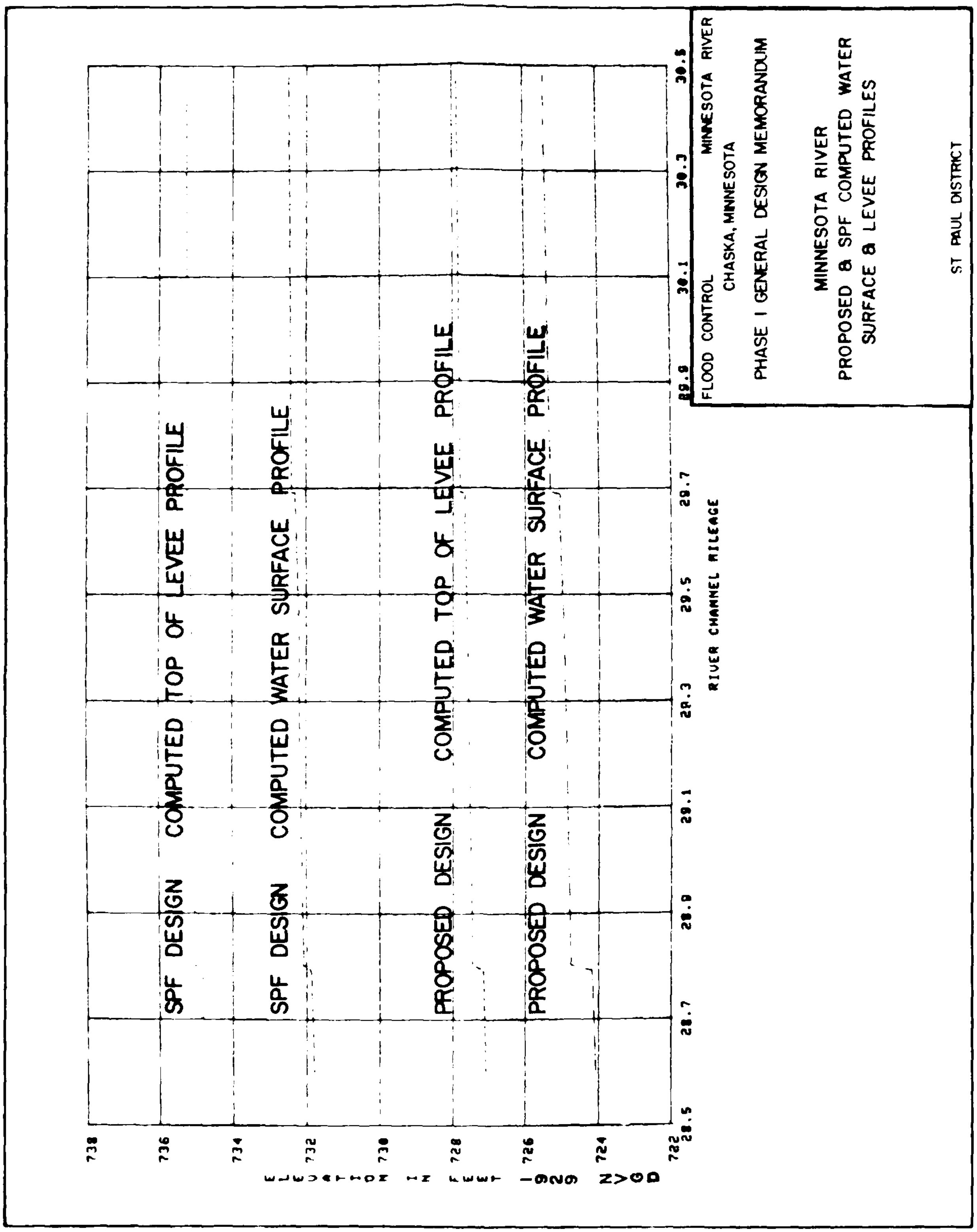
AS SHOWN

DRAWING NUMBER

M34-CH-R-5/8

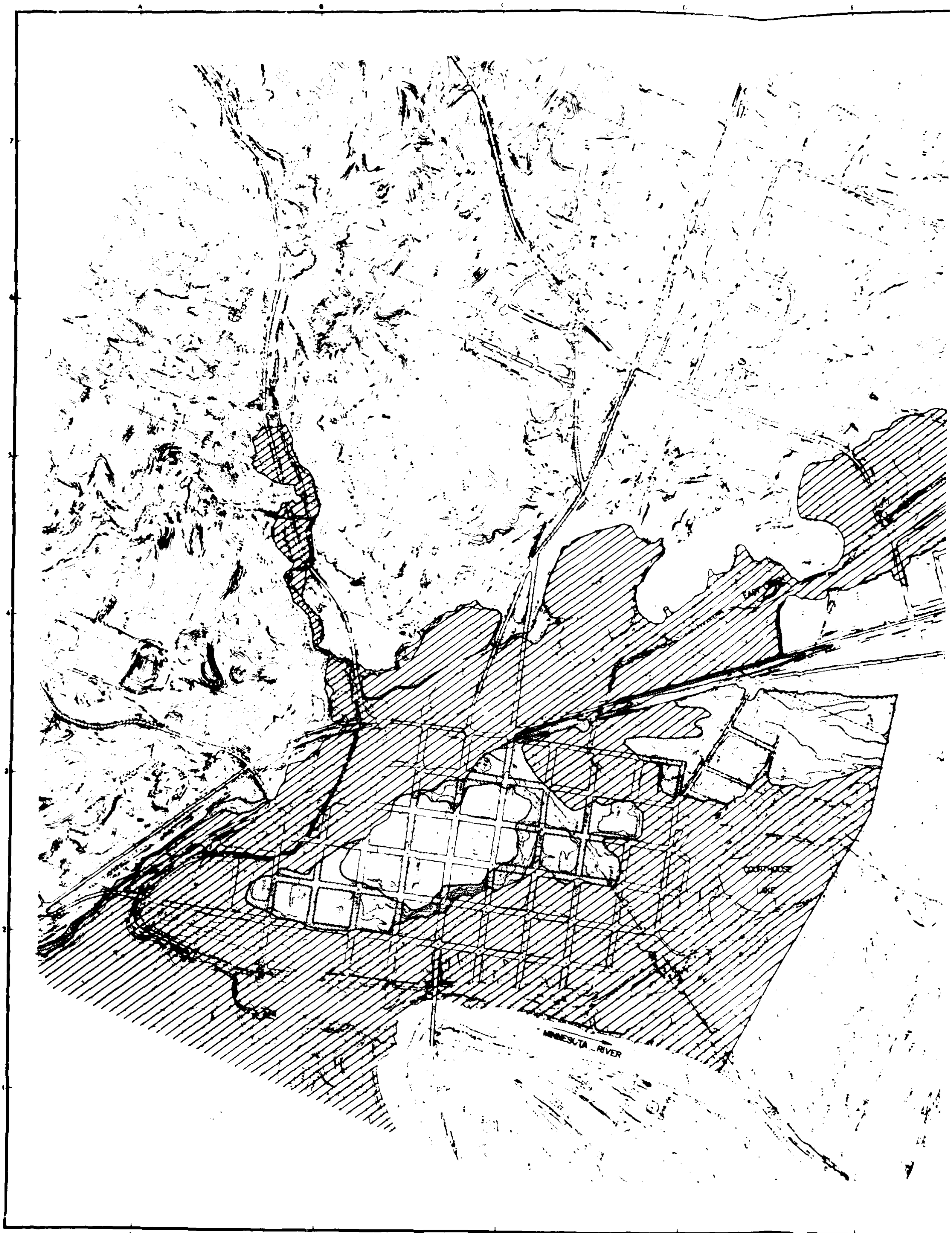
SHEET 2 OF 2

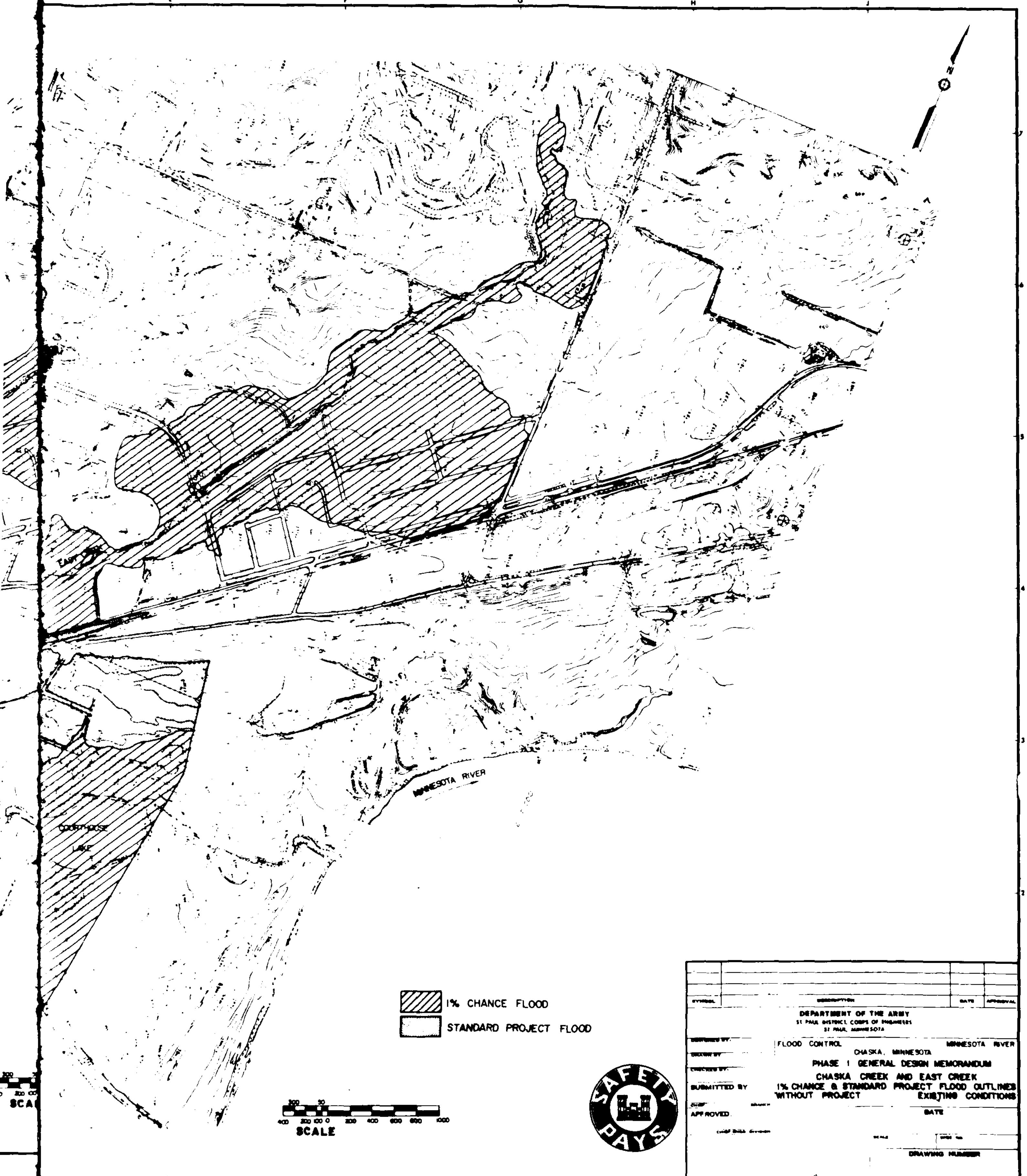
PLATE 4B-44



SPF DESIGN COMPUTED TOP OF LEVEE PROFILE
SPF DESIGN COMPUTED WATER SURFACE PROFILE
PROPOSED DESIGN COMPUTED TOP OF LEVEE PROFILE
PROPOSED DESIGN COMPUTED WATER SURFACE PROFILE
738
736
734
732
730
728
726
724
722
ELEVATION IN FEET - NGVD
28.5
28.7
28.9
29.1
29.3
29.5
29.7
29.9
30.1
30.3
30.5
RIVER CHANNEL MILEAGE
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
MINNESOTA RIVER
PROPOSED & SPF COMPUTED WATER
SURFACE & LEVEE PROFILES
ST PAUL DISTRICT

PLATE 4B-45


COURTHOUSE
LAKE
MINNESOTA RIVER
A
B
C
D
E
1
2
3
4
5
6
7

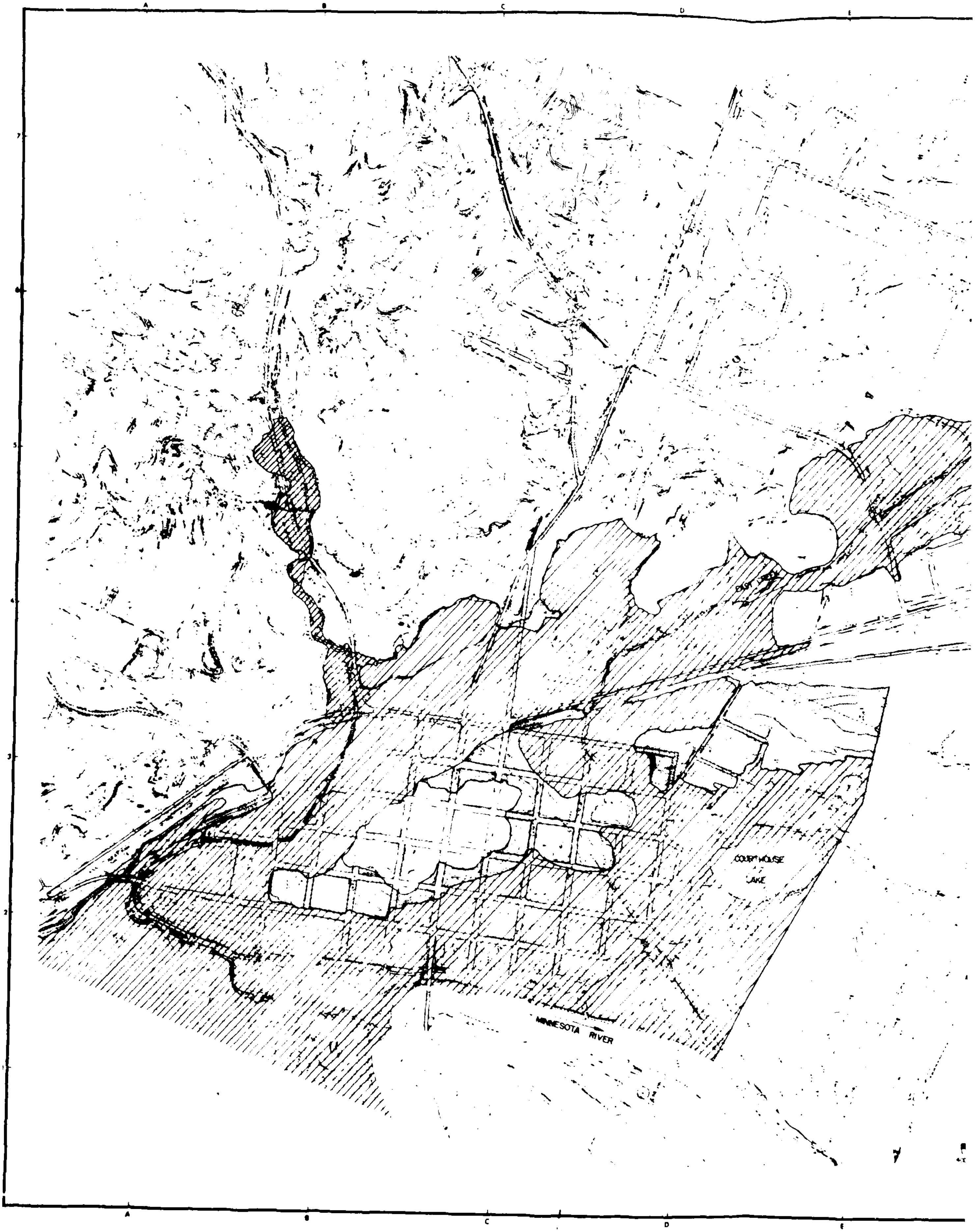


DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

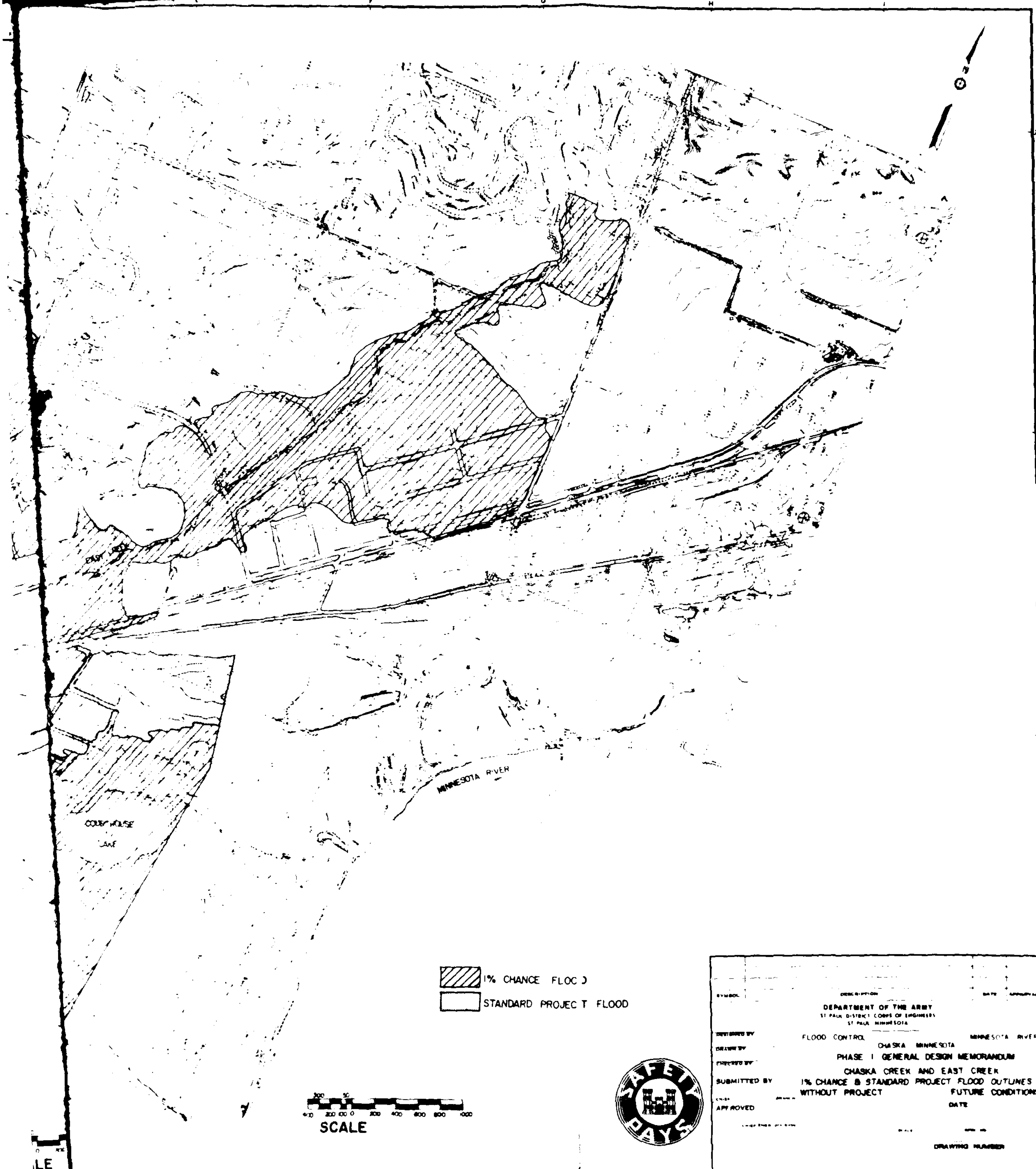
FLOOD CONTROL — MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE 1 GENERAL DESIGN MEMORANDUM
CHASKA CREEK AND EAST CREEK
1% CHANCE & STANDARD PROJECT FLOOD OUTLINES
WITHOUT PROJECT — EXISTING CONDITIONS

SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER

PLATE 48-46



EAST CREEK
COURT HOUSE
LAKE
MINNESOTA RIVER



SYMBOL | DESCRIPTION | DATE | APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
APPROVED

FLOOD CONTROL — CHASKA MINNESOTA — MINNESOTA RIVER

PHASE I GENERAL DESIGN MEMORANDUM

CHASKA CREEK AND EAST CREEK
1% CHANCE & STANDARD PROJECT FLOOD OUTLINES
WITHOUT PROJECT — FUTURE CONDITIONS

DATE

DRAWING NUMBER

PLATE 4B-47

A
B
C
D
E
EAST CREEK
LAKE

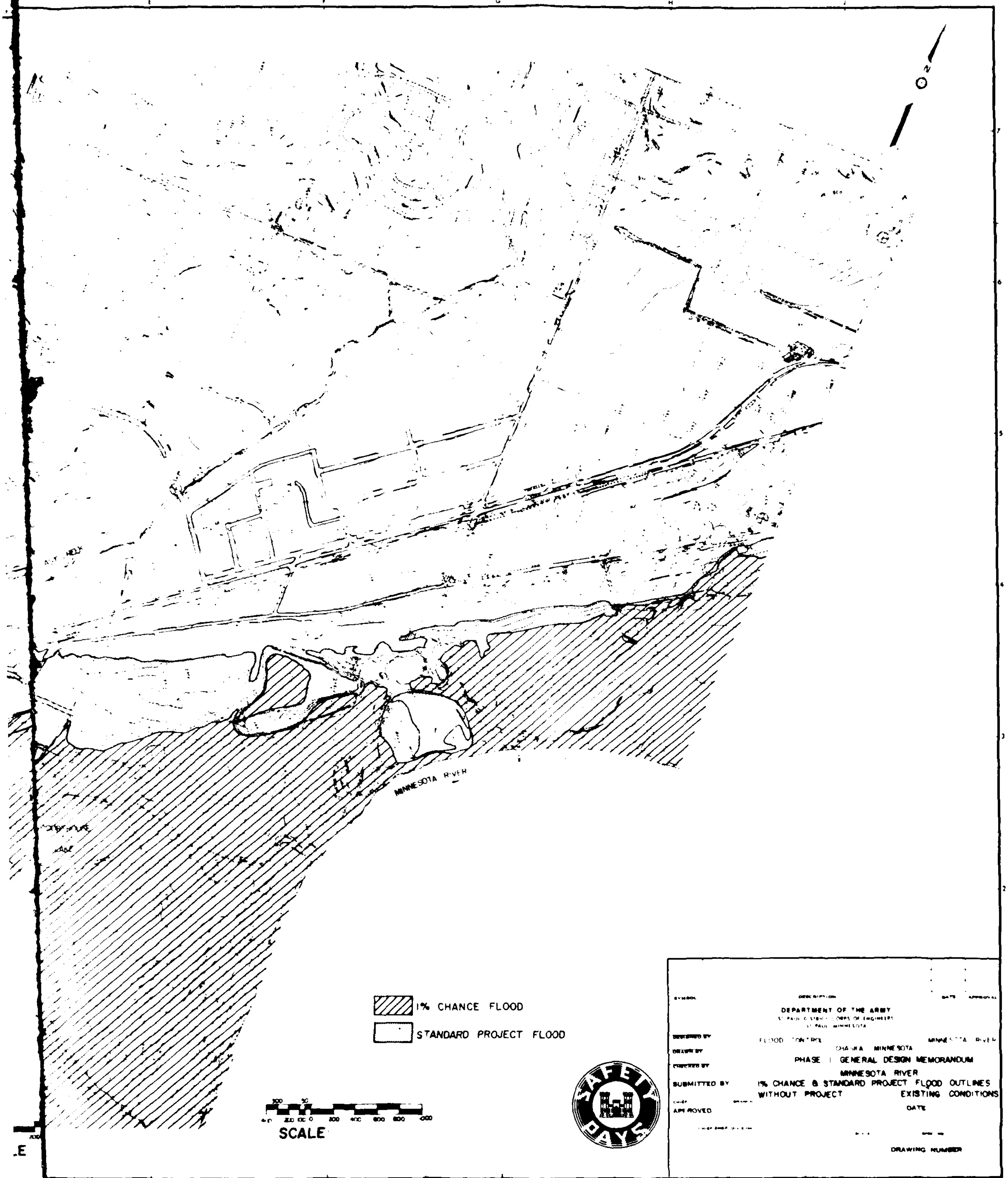
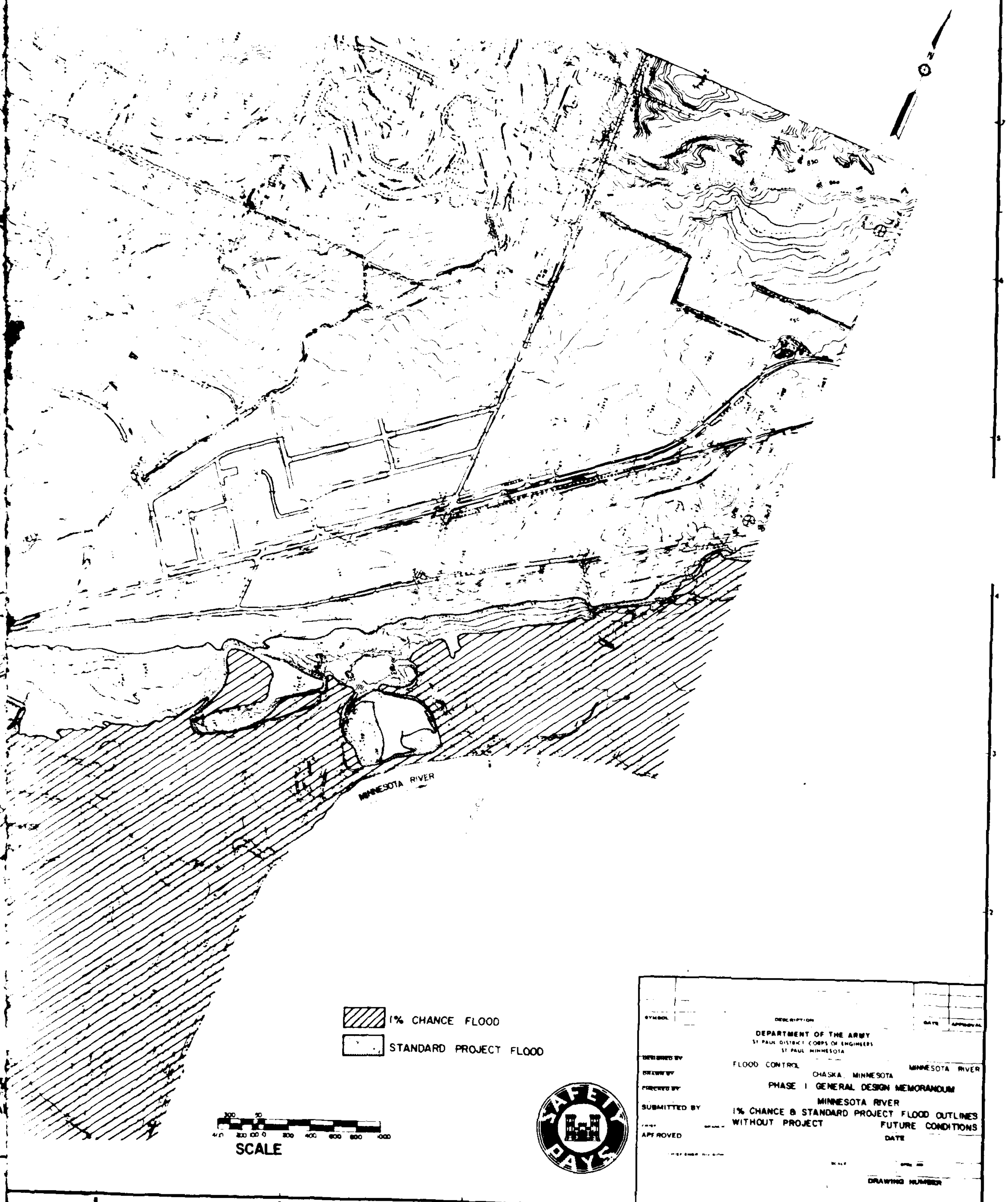

MINNESOTA RIVER
1% CHANCE FLOOD
STANDARD PROJECT FLOOD
SCALE
SAFETY PAYS
SYMBOL
DESCRIPTION
DATE
APPROVAL
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
APPROVED
FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
MINNESOTA RIVER
1% CHANCE & STANDARD PROJECT FLOOD OUTLINES
WITHOUT PROJECT
EXISTING CONDITIONS
DATE
DRAWING NUMBER

PLATE 4B-48


EAST CREEK
COURTHOUSE
LAKE



SYMBOL	DESCRIPTION

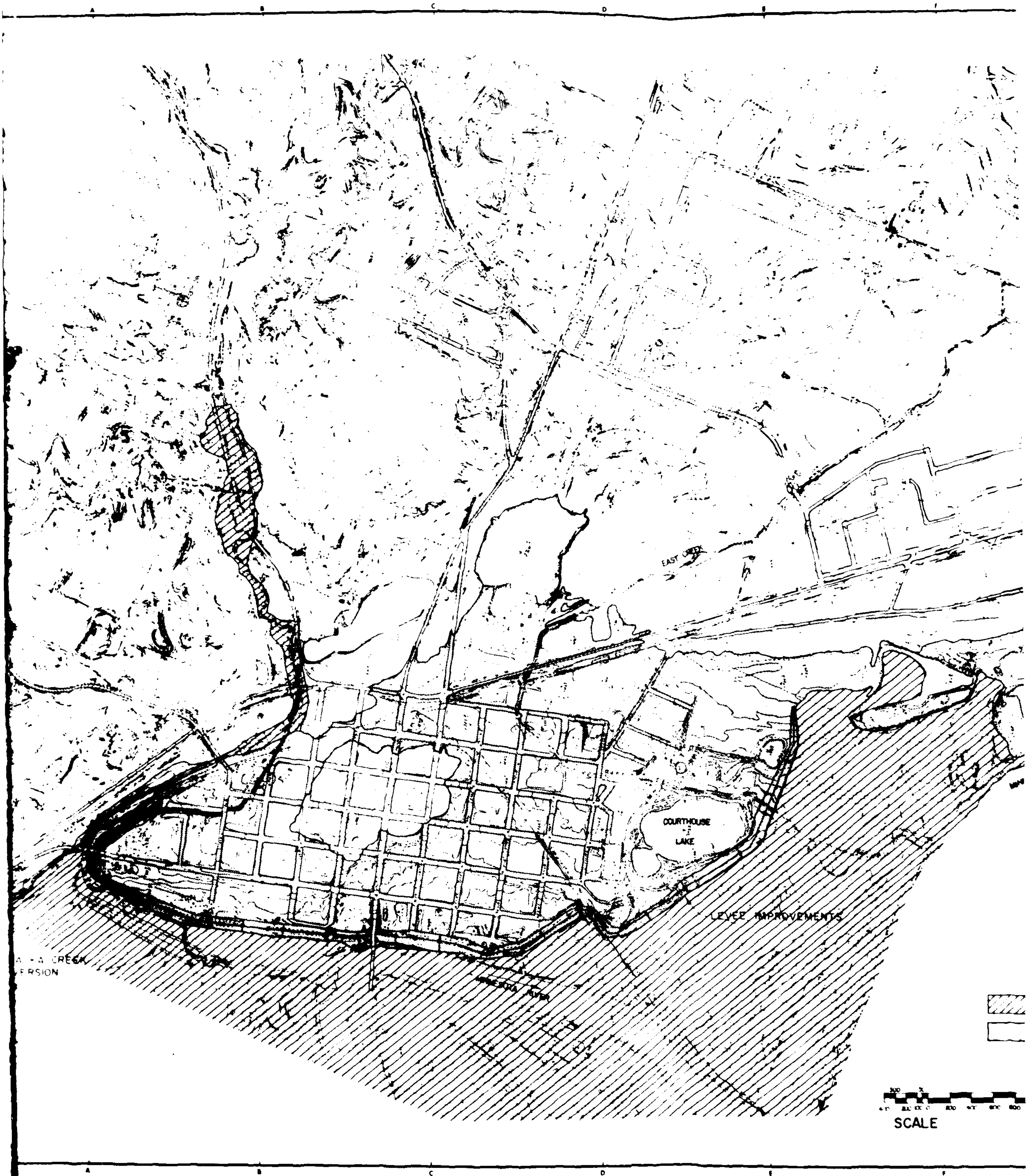
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

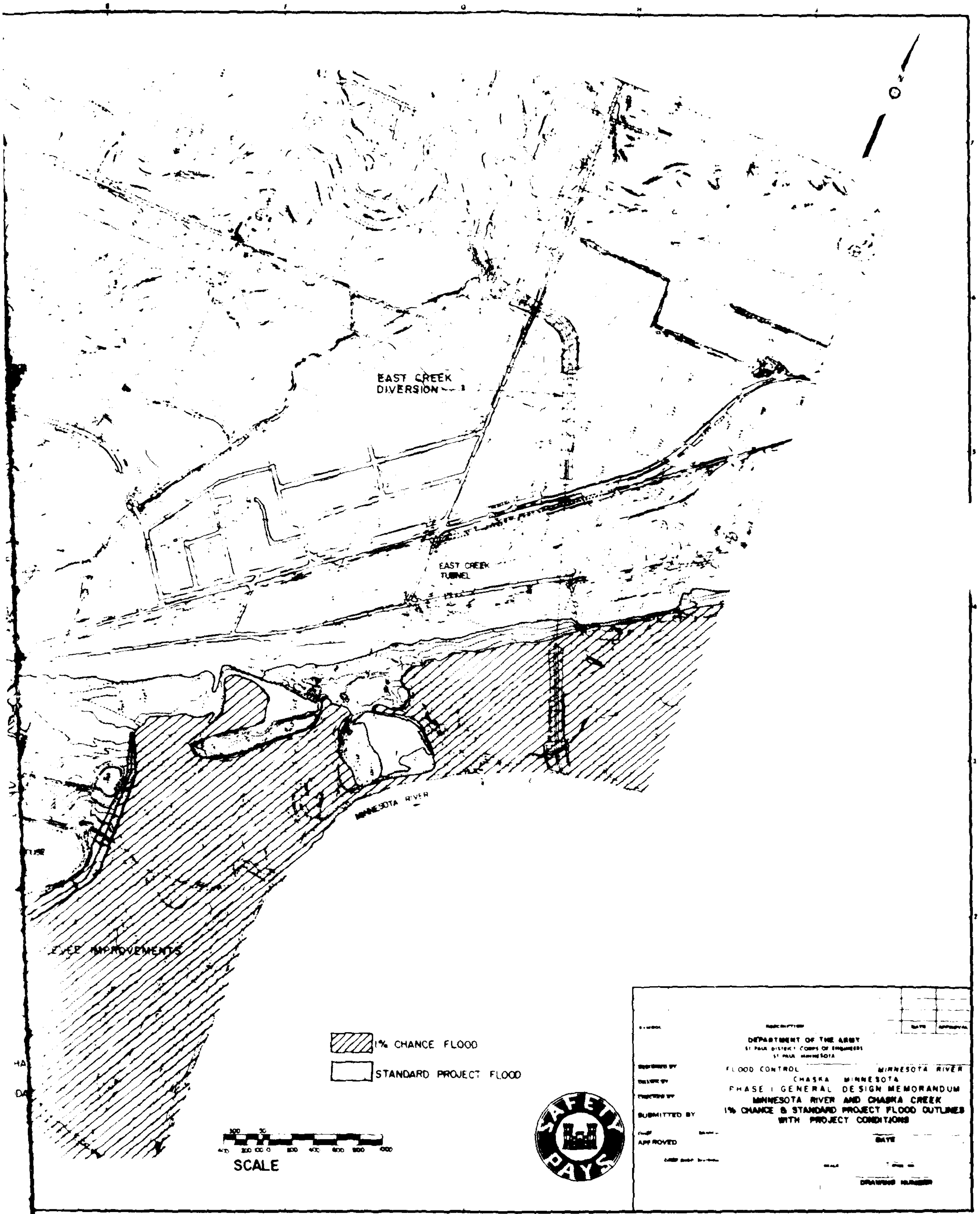
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
APPROVED

FLOOD CONTROL — MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
MINNESOTA RIVER
1% CHANCE & STANDARD PROJECT FLOOD OUTLINES
WITHOUT PROJECT — FUTURE CONDITIONS

DATE
DRAWING NUMBER

PLATE 4B-49


A
B
C
D
E
F
EAST CREEK
COURTHOUSE LAKE
LEVEE IMPROVEMENTS
SCALE



EAST CREEK
DIVERSION
EAST CREEK
TUNNEL
MINNESOTA RIVER
LEVEE IMPROVEMENTS
1% CHANCE FLOOD
STANDARD PROJECT FLOOD
SCALE
SAFETY PAYS
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA
FLOOD CONTROL
MINNESOTA RIVER
CHASKA MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
MINNESOTA RIVER AND CHASKA CREEK
1% CHANCE & STANDARD PROJECT FLOOD OUTLINES
WITH PROJECT CONDITIONS
SUBMITTED BY
APPROVED
DATE
DRAWING NUMBER

PLATE 4B-50

APPENDIX 4C

INTERIOR FLOOD CONTROL

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

TABLES

PLATES

TABLE OF CONTENTS (CONT.)

PLATES

TABLE OF CONTENTS (CONT.)

PLATES

APPENDIX 4C
INTERIOR FLOOD CONTROL

GENERAL

PROJECT PLAN

The proposed interior flood control plan at Chaska, Minnesota, is shown on plate 4C-1. The plan includes gravity outlets (4) through the proposed levee at the existing mouth of Chaska Creek, Pine Street, Ash Street, and the existing mouth of East Creek; one interior culvert from Courthouse Lake to the existing East Creek channel; a stormwater interceptor sewer about 4,150 feet long from just west of Spruce Street to Maple Street; and a 6,800-gpm pumping station at Pine Street. Details of the gravity outlet design and stormwater interceptor sewer design are found on page 4C-1[illegible]. Details of the pumping station design are found on pages 4C-7 through 4C-10.

DEPARTURES FROM THE AUTHORIZED PLAN

In the authorized plan, a 23,800-gpm pumping station was proposed at the Chaska Creek outlet, a 56,000-gpm pumping station at Elm Street, a 59,200-gpm pumping station at Maple Street, and an 84,000-gpm pumping station at the East Creek outlet. The design capacities of the four pumping stations were based on the peak discharge from a coincidental rainfall with a 2.5-year recurrence interval. A detailed probabilistic analysis was performed in this appendix and revealed that pumping stations are not economically justified at any location. Because of seepage accumulation problems along the Minnesota River, one 6,800-gpm pumping station is recommended at Pine Street.

Gravity outlet sizes were increased in section 1 from the previously authorized 54-inch diameter RCP to 66-inch RCP, from 54-inch RCP to 84-inch RCP in section 2, from 72-inch RCP to 84-inch RCP in section 3, and from twin 108-inch RCP's to three 108-inch RCP's in section 4. The range in interceptor sewer pipe sizes also increased based on the more detailed analysis performed in this appendix. The proposed interior culvert between Courthouse Lake and East Creek was reduced from a 72-inch RCP to a 48-inch RCP. The 42-inch RCP recommended between the courthouse drainage area and Courthouse Lake has been eliminated because the existing dike separating the drainage area and the lake is to be removed.

DESCRIPTION OF WATERSHED AND DRAINAGE PATTERNS

The city of Chaska is located along the north floodplain of the Minnesota River. East Creek and Chaska Creek (also known as West Creek) are formed in the rolling countryside north of Chaska and enter the Minnesota River near the populated portion of Chaska. The existing interior flood control basin consists of about 1,130 acres along Chaska Creek, East Creek and the north side of the Minnesota River. The basin, as shown on plate 4C-2 is divided into five major sections, and section 4 is further subdivided into four subsections. The size of each watershed is presented in table 4C-2. Drainage in all areas is currently by overland flow since there is no storm sewer system in Chaska. The section 1 watershed consists of the Chaska Creek watershed downstream from the proposed point of diversion. The section 2 and section 3 watersheds consist of the areas tributary to the existing gated 36-inch RCP outlets at Elm and Maple Streets, the 18-inch RCP gated outlet at Walnut Street, and the gated 24-inch RCP outlet located adjacent to Highway 41, all of which pass beneath the existing dike into the Minnesota River. The section 4 watershed consists of the East Creek watershed located downstream from the proposed point of diversion. Subsection 4-1 is the contributing area between the point of diversion and the Crosstown Boulevard bridge; subsection 4-2 is the contributing area between the Crosstown Boulevard bridge and Highway 212 bridge; subsection 4-3 is the contributing area

between the Highway 212 bridge and Beech Street bridge; and subsection 4-4 is the contributing area downstream from the Beech Street bridge. The Courthouse Lake section consists of the area tributary to Courthouse Lake. Runoff from this lake currently discharges into East Creek (subsection 4-4) through a gated 18-inch CMP. During blocked gravity conditions, two 9,000-gpm pumping stations located at the south end of Elm and Maple Streets are used to remove runoff from sections 2 and 3.

Except for subsections 4-1 and 4-2, all watersheds have a mixture of residential and commercial development. Although subsections 4-1 and 4-2 have some scattered residential development on the hills, much of the area remains undeveloped. The soil consists largely of sand, with impervious layers intermixed in sections 1, 4, and the Courthouse Lake area.

PROPOSED DRAINAGE FEATURES

As shown on plate 4C-1, under proposed conditions Chaska Creek will be diverted around section 1 at the point where it flows under the Chicago and Northwestern railroad track. The existing creek channel within section 1 will then serve as a ponding area. A 66-inch diameter RCP with sluice gate will be located beneath the proposed levee at the downstream end of the old creek channel. In sections 2 and 3, runoff will enter the proposed interceptor sewer through inlets along the line of protection and then enter the river through proposed 84-inch RCP gated outlets located at Pine and Ash Streets. A 6,800-gpm pumping station is to be built near the Pine Street outlet for use during blocked gravity conditions. Runoff from the Courthouse Lake section will temporarily pond in Courthouse Lake and then pass through a gated 48-inch RCP outlet into East Creek. (The 48-inch pipe will replace the existing 18-inch CMP between Courthouse Lake and East Creek.) East Creek will be diverted just upstream of section 4. Section 4 runoff during gravity conditions will enter the river through three 108-inch RCP gated outlets and during blocked gravity conditions will pond adjacent to the gravity outlets.

DESIGN CRITERIA

DEGREE OF PROTECTION

Chaska is considered to be a Class II urban development area, as defined in EM 1110-2-1410 (reference A*). The design of gravity outlets and the interceptor sewer was, therefore, based on the peak inflow from a 50-year annual event during gravity flow (nonflood) conditions. The selection of the required pumping station capacities and gate closure elevations was based on the most economical combination of pumping rates and gate closure elevations which will also limit residual flood damages to only rare occasions and meet design criteria presented in EM 1110-2-3102 (reference C).

PONDING AREAS

Storage-elevation curves for each of the five interior drainage sections are shown on plates 4C-6 through 4C-10. In section 1, ponding will take place in the existing Chaska Creek channel adjacent to the proposed gravity outlet. In sections 2 and 3, ponding will be limited to the areas around the interceptor sewer inlets. Runoff from the Courthouse Lake section will pond in Courthouse Lake. In section 4, ponding will occur at the downstream end of the existing East Creek channel.

DAMAGE-ELEVATION RELATIONSHIPS

Damage-elevation curves for each of the sections are shown as plates 4C-11 through 4C-15. Zero damage elevations are at elevation 718.5 in section 1, 711.0 in section 2, 710.5 in section 3, 719.0 in section 4, and 718.5 in the Courthouse Lake section. The curves shown are based on July 1980 conditions and updated to February 1981 price levels.

---

*This reference and all references which follow are listed on page 4C-13.

STREAMFLOW DATA

Elevation-frequency curves for the Minnesota River at Chaska are shown on plate 4A-4. Stage-discharge curves for the Minnesota River at Chaska Creek and East Creek are shown on plates 4B-8 and 4B-6, respectively. All-year stage-duration curves for the Minnesota River at Chaska Creek and East Creek are shown on plates 4C-4 and 4C-5, respectively. These curves were developed using discharge-duration data obtained for the U.S. Geological Survey gage originally located at Carver, Minnesota (river mile 36.0), from 1936 through October 1966, and presently located near Jordan, Minnesota (river mile 39.4). Both sites for the gage are located upstream of Chaska. The discharges were converted to stages using the above mentioned stage-discharge curves.

RAINFALL DATA

The 1/4-, 1/2, 1-, 2-, 3-, 6-, 12-, 24-, 48-, and 96-hour duration rainfall depths for the 1-, 2.5-, 5-, 10-, 25-, 50-, and 100-year all-year theoretical rainfall events in the Chaska area were developed from National Weather Service (U.S. Weather Bureau) publications HYDRO 35 and TP-40 (references E and F) and are presented in table 4C-1 and on plate 4C-3. The standard project storm, also shown in table 4C-1 and on plate 4C-3, was developed in accordance with EM 1110-2-1411 (reference B).

UNIT HYDROGRAPHS

Unit hydrographs for each of the eight watersheds, shown in table 4C-3, were developed using the SCS unit hydrograph method in the HEC-1 computer program. The parameters necessary to generate the unit hydrographs are shown in table 4C-2. Lag time (L) was calculated using the following formula, found in Soil Conservation Service Technical Release No. (TR) 55 (reference G) as equation 3-2:

$$L = \frac{\ell^{0.8} (S+1)^{0.7}}{1900\ Y^{0.5}}$$

where:

L = Lag in hours

ℓ = Hydraulic length of watershed in feet

$S = \frac{1000}{CN} - 10$ (CN is the SCS curve number)

Y = Average watershed land slope in percent

Curve numbers were obtained from table 2-2 in TR-55 and adjusted to high antecedent moisture conditions (AMC III).

RUNOFF HYDROGRAPHS

Runoff hydrographs for sections 1 thr gh 4 and Courthouse Lake are presented in tables 4C-4 through 4C-10 and were generated using the HEC-1 computer program. Watershed parameters necessary to generate the runoff hydrographs from the SCS unit hydrographs, including SCS curve numbers and percentages of imperviousness, are shown in table 4C-2. The rainfall distributions are from table 4C-1.

SEEPAGE

The estimated average peak seepage rate in section 2 during design conditions is about 1,830 gallons per minute and, in section 3, is about [illegible] gallons per minute. Seepage in the other sections is considered to be negligible. The determination and estimated amounts of seepage are presented in the "Seepage and Uplift Analysis" paragraph in appendix 5.

DESIGN OF GRAVITY FLOW FEATURES

GRAVITY OUTLETS AND STORMWATER INTERCEPTOR SEWER

The proposed locations for the four gravity outlets along the Minnesota River and one interior culvert at the outlet to Courthouse Lake are shown on plate 4C-1 and defined in paragraph 4 and in table 4C-12. All outlets to the Minnesota River will be equipped with gatewells and sluice gates. The outlet from Courthouse Lake will be equipped with a flap gate. The proposed intercepting stormwater sewer is shown on plates 4C-1, 4C-16, and 4C-17 and further defined in table 4C-11. All existing outlets will be abandoned. Discharge rating curves for each of the gravity outlets are presented on plates 4C-18 through 4C-22.

The design of the interceptor sewers and the gravity outlets is based on the criteria presented in TM 5-820-4 (reference D) and on the peak inflow from a 50-year storm. All gravity outlets, culverts and interceptor sewers are to be reinforced concrete pipe. Manning's roughness coefficient is assumed to be 0.013 and the entrance loss coefficient is assumed to be 0.5 for the gravity outlets and interior culvert and 0.2 for the interceptor sewer. The design discharges for the interceptor were determined by applying the following drainage area formula for each contributing subbasin:

$$Qs = \left(\frac{As}{A}\right)^n Q$$

where:

Qs = Discharge of subarea (Design Q)

Q = 50-year peak discharge from tables 4 through 8

As = Subarea size, acres

A = Size of area for which hydrograph was computed

n = Drainage area exponent (0.6 used)

DESIGN OF PUMPING STATION

GENERAL

A new 6,800-gpm stormwater pumping station, equipped with two 3,400-gpm pumps, will be located adjacent to the proposed 84-inch gravity outlet B at the south end of Pine Street. The two existing pumping stations will be abandoned. The selected gate closure elevations are 712.0 at section 1 outlet A and 706.0 at section 2 outlet B, section 3 outlet C, and section 4 outlet D.

EVALUATION OF SELECTED PUMPING CAPACITIES

A probabilistic analysis was performed in order to determine the design pumping station capacities. This method was selected for analysis based on the results of the 1973 feasibility report. The feasibility report studies recommended pumping stations with capacities well in excess of expected seepage rates (seepage was not expected to be a significant factor). Since there is no hourly rain gage at Chaska, use of the period of record method would require the transfer of rainfall records from other rainfall stations in the general area. The analysis performed assumes that gravity outlets will be closed at the selected gate closure elevations, but will be opened again when and if the interior pond level exceeds the river stage by 1.0 foot or more.

RIVER STAGE-DURATION DISTRIBUTIONS

The initial step in performing the probabilistic rainfall-stream-flow analysis is to prepare the stage-duration curves as shown on plates 4C-4 and 4C-5, subdivide the areas beneath the curves into an appropriate number of sections, and obtain the average river stage for each section. As shown on plates 4C-4 and 4C-5, the areas beneath each curve were divided into six sections representing incremental durations of 0.94, 4.22, 7.34, 15.7, [illegible], and 50 percent. The average stages on the Minnesota River at Chaska

Creek (plate 4C-4) for each of the incremental durations are 715.3, 706.9, 698.8, and 688.8, respectively. The average stages on the Minnesota River at East Creek (plate 4C-5) for each of the incremental durations are 717.4, 706.8, 703.4, 698.6, 694.0, and 688.8. River stages from plate 4C-4 were used for sections 1, 2, and 3 computations. Water levels in Courthouse Lake were found to be largely independent of river stage.

MAXIMUM POND LEVELS

The maximum interior pond levels shown in table 4C-13 were obtained by routing the seven runoff hydrographs for each area (standard project storm not included) through the existing ponding area and selected pumping station (with supplemental gravity flow if applicable) for each of the selected river stages. Elevation-storage data for each of the outlets appear on plates 4C-18 through 4C-22. Runoff hydrographs for the rainfall events are presented in tables 4C-4 through 4C-10.

POND LEVEL FREQUENCY RELATIONSHIPS

The pond level frequency relationships based on the selected river stages, pump rates, and rainfall events investigated are presented on plates 4C-23 through 4C-36. As indicated, each plate represents a single pumping condition for a given section. The curves were obtained by plotting the maximum pond levels versus the rainfall frequency values shown in table 4C-13.

POND LEVEL EXCEEDENCE PROBABILITIES

The pond level exceedence probabilities are presented in table 4C-15. The index river stages and durations indicated in the table were obtained as explained on page 4C-8. The exceedence probabilities for the various index river stages indicated in table 4C-15 were obtained from plates 4C-23 through 4C-36. The coincidental pond level exceedence probability was obtained by multiplying the pond level exceedence probability at each river

stage by the duration of each river stage. These coincidental probabilities for each pond level index river stage combination were summed to obtain the chance of exceedence. The damages indicated in table 4C-15 were obtained from the damage-elevation curves shown on plates 4C-11 through 4C-15 and represent the damages at the selected pond level. Pond level-coincidental frequency curves for each area are presented on plates 4C-37 through 4C-42.

DAMAGE-FREQUENCY CURVES

Damage-frequency curves for section 2, section 3, and sections 2 and 3 combined (one outlet) are presented on plates 4C-43 through 4C-45. The curves are based on the damage-frequency values presented in table 4C-[illegible]. No curves appear for section 1, section 4, or Courthouse Lake since the ponding areas were found to be capable of holding all interior runoff with no resulting damages. Average annual damages are equal to the area under each curve. Average annual benefits are equal to the difference between average annual damages with and without pumping.

ECONOMIC EVALUATION

Benefit-cost curves for section [illegible], section [illegible], and [illegible] and [illegible] combined (one outlet) appear on plate 4C-47. The average annual benefits for various pumping rates were obtained from plates 4C-[illegible] through 4C-[illegible]. The average annual costs for these pumping station sizes were obtained from the pump cost-capacity curve presented on plate 4C-[illegible] which is based on the pumping station costs presented in the interior drainage appendixes for the Winona, Minnesota, design memorandums [illegible], and [illegible] updated to February [illegible] price levels.

None of the benefit-cost curves shown on plate 4C-[illegible] [illegible] maximum net benefits where the average annual [illegible] increasing at the same rate. Thus, pumping stations are [illegible] justified in any section of the interior flood control area.

HISTORICAL EVENTS DURING BLOCKED GRAVITY CONDITIONS

Table 4C-16 presents the periods of blocked gravity conditions during the years 1961 through 1979 had the proposed project been in operation. Also shown are the number of days of gate closure for each event, the total rainfall during each event, and the rainfall excess, assuming 70-percent runoff. The most severe event in terms of total rainfall and river stage occurred in 1965. Maximum pond levels of 712.8, 710.0, 718.1, and 706.2 would have been reached in section 1, sections 2/3, section 4, and Courthouse Lake, respectively. No damages would have resulted.

JUSTIFICATION

Based on a probabilistic analysis, pumping stations cannot be economically justified. However, a pumping station with a capacity of 6,800 gpm and located at Pine Street is recommended to reduce damages in the section 2 and 3 areas from seepage accumulation and blocked gravity conditions during the occurrence of long duration flood stages on the Minnesota River. No pumping station is recommended for section 4 because sufficient ponding area appears to be available. If no pumping station were provided, damage from the 1969 event (see table 4C-16) would be about $3.4 million and a peak ponding elevation of about 724.[illegible] would be reached. Similarly, damages from the 1965 and 1952 events would total about $[illegible] million and $6[illegible],000, respectively, as ponding elevations of about 7[illegible] and 713.4 would be reached. These damages are considered excessive because of the frequency with which they would have occurred (three times in [illegible] years), and would have presented hazardous conditions to the residents within the area adjacent to the levee in sections 2 and 3. Currently, the city has two pumping stations capable of handling seepage from these events. Thus, a permanent pumping station is recommended.

Gate closure elevations selected are 712.0 at the section 1 outlet and 706.0 at the section 2, section 3, and section 4 outlets. Lower gate closure elevations were not selected because the number of days of blocked gravity conditions becomes excessive and there was little increase in available storage. Gate closure at higher elevations would result in substantial damages because of inadequate storage available.

ONE-PERCENT AND SPS POND LEVELS

One-percent (100-year) and standard project storm pond levels for preproject and postproject conditions are presented in table 4C-16. The 100-year and standard project storm flood limits for postproject conditions are shown on plate 4C-48. An emergency levee is currently located along the south side of sections 1, 2 and 3 and around [illegible] Lake. Thus, elevations expected under postproject conditions in these sections will differ little from preproject elevations. In all sections under postproject conditions, there will be no damage during the 100-year storm. Damages from the standard project storm for postproject conditions are not excessive or hazardous.

OTHER ALTERNATIVES CONSIDERED

In addition to the recommended design, other alternative designs were considered. The alternative studied was the construction of a [illegible]-gpm pumping station in section [illegible] and a [illegible]-gpm pumping station in section [illegible]. The average annual cost of the two-station alternative would be [illegible] per year compared with an average annual cost of [illegible] per year for the recommended [illegible]-gpm [illegible] Street pumping station [illegible]. Thus, the recommended plan was [illegible] economical.

Also studied was a [illegible] interceptor sewer, rather than the proposed two-station [illegible] Street and Ash Street. The preliminary cost estimate for the [illegible] alternative was about $[illegible], compared with an estimated [illegible] of $1,190,000 for the proposed two-station system. Thus, the two-station plan was recommended.

Ponding some of the runoff from [illegible] Lake was initially investigated but rejected since the city wishes to maintain high water quality standards in [illegible] Lake and adequate storage is available at the downstream end of section 4.

REFERENCES

A. EM 1110-2-1410, Interior Drainage of Leveed Urban Areas; Hydrology.

B. EM 1110-2-1411, Standard Project Flood Determinations (Civil Works Engineer Bulletin No. 52-8, March 1952).

C. EM 1110-2-3102, General Principles of Pumping Station Design and Layout.

D. TM 5-820-4, Drainage for Areas Other than Airfields

E. National Weather Service Technical Report No. 40, "Rainfall Frequency Atlas of the United States," May 1961.

F. National Weather Service HYDRO-35, "Five- to 60-Minute Precipitation Frequency for the Eastern and Central United States, June 1977.

G. Soil Conservation Service Technical Release No. 55, "Urban Hydrology for Small Watersheds, January 1975.

H. "Climatological Data," National Oceanic and Atmospheric Administration, Environmental Data Service, U.S. Department of Commerce.

I. "Data Book for Civil Engineers-Design," by Elwyn E. Seelye, Volume 1, 5th Printing, May 1966.

J. "Flood Control, Mississippi River at Winona, Minnesota, Design Memorandum No. 3, Reach B," U.S. Army Corps of Engineers, St. Paul District, March 1981.

K. "Flood Control, Mississippi River at Winona, Minnesota, Design Memorandum No. 4, Reach C," U.S. Army Corps of Engineers, St. Paul District, June 1980.

L. "Flood Control, Mississippi River at Winona, Minnesota, Design Memorandum No. 5, Reach D," U.S. Army Corps of Engineers, St. Paul District, November 1980.

M. "Interior Drainage Analysis for Flood Control Project - Minnesota River at Chaska, Minnesota," by Barr Engineering Company, Consulting Engineers, for the U.S. Army Corps of Engineers, St. Paul District, 1980.

Table 4C-1 - Theoretical rainfall amounts, accumulated 96-hour theoretical rainfall amounts

Rainfall duration in hours	Average Exceedence Interval in Years							
	1-Yr.	2.5-Yr.	5-Yr.	10-Yr.	25-Yr.	50-Yr.	100-Yr.	SPS
1/2	0.90	1.23	1.44	1.67	1.89	2.16	2.50	2.90
1	1.14	1.51	1.75	2.06	2.32	2.63	3.00	3.66
1 1/2	1.25	1.68	1.94	2.29	2.58	2.95	3.27	4.38
2	1.33	1.81	2.09	2.47	2.79	3.16	3.53	5.10
2 1/2	1.40	1.90	2.21	2.59	2.94	3.32	3.72	5.80
3	1.46	1.98	2.30	2.71	3.06	3.47	3.88	6.44
3 1/2	1.51	2.05	2.38	2.81	3.18	3.59	3.99	7.02
4	1.55	2.11	2.43	2.89	3.28	3.69	4.09	7.59
4 1/2	1.59	2.17	2.49	2.96	3.37	3.79	4.18	8.14
5	1.63	2.23	2.55	3.02	3.45	3.87	4.26	8.64
5 1/2	1.67	2.28	2.60	3.08	3.51	3.94	4.34	9.12
6	1.69	2.33	2.65	3.14	3.57	4.01	4.41	9.60
12	1.85	2.60	3.00	3.50	4.10	4.60	5.10	10.91
18	2.00	2.85	3.30	3.80	4.50	5.10	5.60	11.71
24	2.15	2.95	3.50	4.00	4.75	5.40	5.95	12.10
48	2.60	3.50	4.10	4.60	5.60	6.40	7.00	13.50
72	2.85	3.80	4.50	5.10	6.15	7.00	7.65	14.10
96	3.15	4.15	4.85	5.55	6.60	7.45	8.20	14.30
Rainfall distribution in hours								
1	0.06	0.10	0.10	0.12	0.12	0.14	0.15	0.10
2	0.08	0.12	0.12	0.13	0.17	0.18	0.24	0.10
3	0.09	0.13	0.13	0.18	0.22	0.22	0.32	0.16
4	0.13	0.17	0.21	0.24	0.27	0.31	0.35	0.20
5	0.19	0.30	0.34	0.41	0.47	0.53	0.53	0.23
6	1.14	1.51	1.75	2.06	2.32	2.63	3.00	0.52
7								0.96
8								1.05
9								1.15
10								1.34
11								1.44
12								3.66

* Rainfall amounts for the standard project storm are for a maximum 12-hour period rainfall. For other events, rainfall amounts are for a maximum 6-hour period rainfall.

Table 4C-2 - Drainage area parameters

Section	Sub-section	Area (mi.^{2})	Area (acres)	Slope (ft/ft)	Watershed length(ft.)	Lag time L[1]	Percent impervious	SCS curve number CN[2]
1		0.06	36	0.010	2,800	0.31	0.30	93
2		0.08	52	0.020	2,000	0.13	0.35	92
3		0.09	58	0.012	2,600	0.23	0.45	93
4	4-1	0.66	424	0.049	3,400	0.25	0.05	92
	4-2	0.53	336	0.053	3,600	0.25	0.10	92
	4-3	0.14	91	0.013	1,500	0.25	0.30	92
	4-4	0.16	103	0.013	1,500	0.16	0.30	92
Court-house Lake		0.04	25	0.023	900	0.11	0.60	94

(1) See paragraph 10 for definition
(2) Antecedent moisture condition (AMC) III.

Table 4C-3 - Unit hydrographs

Section/ subsection	1	2	3	4				Courthouse Lake
				4-1	4-2	4-3	4-4	
0:05	11	99	47	194	156	41	47	36
0:10	35	224	152	663	532	141	161	64
0:15	68	165	183	1055	847	224	256	33
0:20	81	71	141	1055	847	224	256	13
0:25	77	33	76	822	660	174	199	5
0:30	63	15	44	492	395	104	119	2
0:35	42	7	24	306	246	65	74	1
0:40	28	3	14	198	159	42	48	0
0:45	19	2	8	123	99	26	30	0
0:50	13	0	4	77	62	16	19	
0:55	9		2	48	39	10	12	
1:00	6		2	30	24	6	7	
1:05	4		1	19	15	4	5	
1:10	3		0	12	10	3	3	
1:15	2			8	7	2	2	
1:20	1			5	4	1	1	
1:25	1			2	1	0	0	
1:30	1							

Table 4C-4 - Rainfall runoff hydrographs for section 1

Time	1 yr.	2.5 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.	SPS
0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	0	0	0
2.0	0	0	0	1	1	2	2	0
2.5	0	1	1	2	2	3	3	1
3.0	0	2	2	3	4	4	5	2
3.5	1	2	2	5	5	6	7	3
4.0	2	3	5	6	7	8	10	4
4.5	3	5	7	10	11	11	13	5
5.0	4	8	10	14	15	18	16	6
5.5	9	14	16	24	24	28	28	11
6.0	51	76	92	120	122	144	167	17
6.5	20	32	40	45	54	64	72	29
7.0	2	3	4	4	5	6	7	33
7.5	0	0	0	0	0	1	1	39
8.0						0	0	43
8.5								51
9.0								54
9.5								55
10.0								198
10.5								116
11.0								57
11.5								45
12.0								42
12.5								11
13.0								1
13.5								0
14.0								

Table 4C-5 - Rainfall runoff hydrographs for section 2

Time	1 yr.	2.5 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.	SPS
0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	0	0	0
2.0	0	0	0	1	2	2	3	0
2.5	0	1	1	3	3	3	3	1
3.0	0	2	3	3	5	6	7	3
3.5	1	3	3	6	7	9	10	5
4.0	2	4	6	7	9	12	13	6
4.5	3	9	9	12	16	17	17	7
5.0	6	14	14	18	22	28	22	8
5.5	16	22	26	33	40	45	47	17
6.0	89	151	198	228	262	317	357	24
6.5	2	4	5	6	7	9	10	42
7.0	0	0	0	0	0	0	0	45
7.5								56
8.0								58
8.5								71
9.0								72
9.5								76
10.0								383
10.5								78
11.0								64
11.5								56
12.0								55
12.5								1
13.0								0
13.5								
14.0								

Table 4C-6 - Rainfall runoff hydrographs for section 3

Time	1 yr.	2.5 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.	SPS
0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	1	1	0
2.0	0	1	1	1	2	3	4	0
2.5	0	2	1	4	4	5	4	1
3.0	1	3	3	4	7	7	8	3
3.5	2	3	4	7	8	11	12	5
4.0	3	5	8	9	12	14	15	6
4.5	5	9	11	14	18	19	20	7
5.0	7	14	16	21	25	30	26	10
5.5	17	24	28	36	42	48	50	18
6.0	96	147	181	208	239	282	332	27
6.5	10	16	21	25	28	34	37	46
7.0	0	0	1	1	1	1	1	51
7.5			0	0	0	0	0	61
8.0								65
8.5								79
9.0								82
9.5								84
10.0								341
10.5								132
11.0								78
11.5								64
12.0								63
12.5								8
13.0								1
13.5								0
14.0								

Table 4C-7 - Rainfall runoff hydrographs for sections 2 and 3

Time	1 yr.	2.5 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.	SPS
0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	1	1	0
2.0	0	1	1	2	4	5	7	0
2.5	0	3	2	7	7	8	7	2
3.0	1	5	6	7	12	13	15	6
3.5	3	6	7	13	15	20	22	10
4.0	5	9	14	16	18	26	28	12
4.5	8	18	20	26	34	36	37	14
5.0	13	28	30	39	47	58	48	18
5.5	33	46	54	69	76	93	97	35
6.0	185	298	379	436	503	599	689	51
6.5	12	20	26	31	35	43	47	88
7.0	0	0	1	1	1	1	1	96
7.5			0	0	0	0	0	117
8.0								123
8.5								150
9.0								154
9.5								160
10.0								724
10.5								210
11.0								142
11.5								120
12.0								118
12.5								9
13.0								1
13.5								0
14.0								

Table 4C-8 - Rainfall runoff hydrographs for section 4
(includes 80-cfs constant inflow from diversion)

Time	1 yr.	2.5 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.	SPF
0	80	80	80	80	80	80	80	80
0.5	80	80	80	80	80	80	80	80
1.0	80	80	80	80	80	80	80	80
1.5	80	80	80	80	80	80	80	80
2.0	80	80	80	81	82	85	89	80
2.5	80	81	82	88	100	109	117	81
3.0	80	94	94	111	131	140	158	93
3.5	81	108	110	140	172	180	200	119
4.0	88	125	138	179	201	222	266	146
4.5	101	150	185	210	246	277	329	170
5.0	116	198	229	286	340	362	418	188
5.5	142	273	320	401	461	558	558	238
6.0	212	457	607	770	859	1055	1123	367
6.5	473	884	1207	1428	1535	1736	1876	539
7.0	1006	1407	1649	2028	2407	2787	3445	805
7.5	108	147	132	139	156	163	183	918
8.0	80	80	80	80	81	81	81	1038
8.5	80	80	80	80	80	80	80	1160
9.0	80	80	80	80	80	80	80	1334
9.5	80	80	80	80	80	80	80	1419
10.0	80	80	80	80	80	80	80	1815
10.5	80	80	80	80	80	80	80	2751
11.0	80	80	80	80	80	80	80	3919
11.5	80	80	80	80	80	80	80	1515
12.0	80	80	80	80	80	80	80	1169
12.5	80	80	80	80	80	80	80	976
13.0	80	80	80	80	80	80	80	265
13.5	80	80	80	80	80	80	80	91
14.0	80	80	80	80	80	80	80	80

Table 4C-9 - Rainfall runoff hydrographs for section 4
(not including 80-cfs constant inflow from diversion)

Time	1 yr.	2.5 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.	SPS
0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	0	0	0
2.0	0	0	0	1	2	5	9	0
2.5	0	1	2	8	20	29	37	1
3.0	0	14	14	31	51	60	78	13
3.5	1	28	30	60	92	100	120	39
4.0	8	45	58	99	121	142	146	66
4.5	21	70	105	130	166	197	249	90
5.0	36	118	149	206	260	282	338	108
5.5	62	193	240	321	381	478	478	158
6.0	132	377	527	690	779	975	1043	287
6.5	393	804	1127	1348	1455	1656	1796	459
7.0	926	1327	1569	1948	2327	2707	3365	725
7.5	28	67	52	59	76	83	103	838
8.0	0	0	0	0	1	1	1	958
8.5					0	0	0	1080
9.0								1254
9.5								1339
10.0								1735
10.5								2671
11.0								3839
11.5								1435
12.0								1089
12.5								896
13.0								185
13.5								11
14.0								0

Table 4C-10 - Rainfall runoff nydrographs for Courthouse Lake

Time	1 yr.	2.5 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.	SPS
0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	0	2	0
2.0	0	0	0	0	2	2	2	0
2.5	0	0	0	2	2	2	4	0
3.0	0	2	2	4	4	4	4	2
3.5	2	2	2	4	4	6	6	4
4.0	2	4	4	4	6	6	8	4
4.5	2	4	6	8	10	10	10	4
5.0	4	6	8	10	12	16	14	6
5.5	10	12	16	20	22	28	24	10
6.0	50	80	92	114	134	150	184	14
6.5	0	2	2	2	2	2	2	22
7.0		0	0	0	0	0	0	24
7.5								28
8.0								30
8.5								36
9.0								36
9.5								38
10.0								196
10.5								38
11.0								32
11.5								28
12.0								28
12.5								0
13.0								
13.5								
14.0								

Table 4C-1[illegible] - Interceptor sewer design

Inlet watershed name	Location from	Location to	Incremental watershed area/acres	Total contributing watershed in acres	Factor $\left(\frac{A_s}{A}\right)^{0.6}$	Design Q	Pipe size & type	Length feet	Pipe slope percent	Pipe invert elevation Inlet	Pipe invert elevation Outlet	Water surface elevation	Inlet control
Section 2													
A1	Inl 1	Inl 2	14.4	14.4	0.46	146	66" RCP	600	0.25	703.5	702	708.7	X
A2	Inl 2	Inl 3	6.4	20.8	0.58	184	72" RCP	400	0.25	701.5	700.5	707.0	
A3	Inl 3	Inl 4	8.1	28.9	0.70	222	78" RCP	350	0.25	699.8	699	706.8	
A4	Inl 4	Inl 5	10.6	39.5	0.85	269	84" RCP	500	0.25	698.5	697.5	705.5	
A5	Inl 5	Outlet B	9.0	52.0	1.0	317	84" RCP	200	0.50	696.5	695.5	703.9	X
A6	Inl 6	Inl 5	3.5	3.5	0.20	63	54" RCP	250	0.25	700.6	700 ^5	704.4	
Section 3													
A7	Inl 7	Inl 8	16.8	16.8									
A8	Inl 8	Inl 9	17.2	34.0	0.51	144	78" RCP	400	0.14	699.5	699	706.9	
A9	Inl 9	Outlet C	11.4	58.0	0.77	217	84" RCP	400	0.14	698.5	698	705.8	
A10	Inl 10	Inl 9	12.6	12.6	1.0	282	84" RCP	200	0.50	698	697	704.7	X
					0.40	113	66" RCP	400	0.18	700.3	699.5	705.5	
Section 2 - section 3 connector (1)													
	Inl 7	Inl 6				7	24" RCP	450	0.25	704	703.25		

(1) Designed to carry the peak seepage flow to the proposed pumping station during blocked gravity conditions.
(NOTE): An entrance loss coefficient of 0.2 and a Manning's "n" of 0.013 were assumed.

Table 4C-12 - Design of gravity outlets and interior culvert

Culvert/outlet identification	A	B	C	D	E	(1)
Location	Section 1	Section 2	Section 3	Section 4	Courthouse Lake	Sections 2 and 3
Pipe diameter (in.)	66	84	84	108	48	108
Number of pipes required	1	1	1	3	1	1
Design discharge, cfs	144	317	282	2,787	150	599
Slope, ft./ft.	0.005	0.005	0.005	0.008	0.010	0.0018
Upstream invert elevation	709.5	697.5	698.0	699.4	703.0	695.5
Approx'mate length, ft.	100	200	200	145	50	130
Maximum design water surface elevation	714.2	703.9	704.7	712.9	710.6	705.1
Maximum allowable water surface elevation	718.5	711.0	710.5	719.0	718.5	711.0
Inlet control		X	X	X	X	
Type of gate(s) required	Sluice	Sluice	Sluice	Sluice	Flap	Sluice

(1) Alternative design which was studied, but rejected.

NOTE: All pipes are reinforced concrete pipes (RCP).
An entrance loss coefficient of 0.5 and a Manning's "n" of 0.013 was assumed.

Table 4C-13 - Interior pond levels assuming gates reopen at 1.0-foot head

River stage/freq.	1-Yr.	2.5-Yr.	5-Yr.	10-Yr.	25-Yr.	50-Yr.	100-Yr.
Section 1 - no pumping							
688.8	712.4	712.8	713.1	713.7	713.7	714.2	714.6
693.8	712.4	712.8	713.1	713.7	713.7	714.2	714.6
698.5	712.4	712.8	713.1	713.7	713.7	714.2	714.6
703.0	712.4	712.8	713.1	713.7	713.7	714.2	714.6
706.9	712.4	712.8	713.1	713.7	713.7	714.2	714.6
715.3	716.4	716.4	716.4	716.5	716.5	716.6	716.9

Table 4C-15 - Interior pond levels [illegible] gates reopen at 1.0-foot head [illegible]

River stage/freq.	1-Yr.	2.5-Yr.	5-Yr.	10-Yr.	[illegible]	[illegible]	100-Yr.
Section 2 - no pumping							
688.8 (1)	701.3	701.3	703.8	704.3	704.8	705.7	706.4
693.8 (1)	701.3	703.1	703.8	704.3	704.8	705.7	706.4
698.5 (1)	701.3	703.1	703.8	704.3	704.8	705.7	706.4
703.0 (1)	703.4	703.6	703.8	704.3	704.8	705.7	706.4
706.9	707.9	708.0	708.0	708.0	708.1	708.8	709.1
715.3	711.3	711.9	712.3	712.5	712.9	713.3	713.6
Section 2 - 3,000-GPM pumping station							
706.9	707.9	708.0	708.0	708.0	708.1	708.7	709.0
715.3	710.8	711.2	711.4	711.7	712.0	712.2	712.5
Section 2 - 5,000-GPM pumping station							
706.9	707.9	708.0	708.0	708.0	708.0	708.6	708.9
715.3	710.7	711.1	711.3	711.6	711.8	712.1	712.3
Section 2 - 10,000-GPM pumping station							
706.9	707.9	708.0	708.0	708.0	708.0	708.5	708.8
715.3	710.5	710.9	711.1	711.3	711.6	711.8	712.0

(1) Note: Interior pond levels at these river stages remain constant regardless of pumping station size.

Table 4C-1[illegible] - Interior pond levels assuming gates to be [illegible] at 1.0-foot head, cont.

Stage/freq.	1-Yr.	2.5-Yr.	5-Yr.	10-Yr.	25-Yr.	50-Yr.	100-Yr.
Section 3 - no pumping							
688.8 (1)	702.1	703.5	704.1	704.5	705.0	705.7	706.5
693.8 (1)	702.1	703.5	704.1	704.5	705.0	705.7	706.5
698.5 (1)	702.1	703.5	704.1	704.5	705.0	705.7	706.5
703.0 (1)	703.4	703.6	704.1	704.5	705.0	705.7	706.5
706.9	708.0	708.0	708.0	708.0	708.0	708.3	709.0
715.3	711.9	712.6	713.1	713.5	714.0	714.5	714.8
Section 3 - 5,000-GPM pumping station							
706.9	707.3	707.5	707.6	707.8	707.8	708.2	708.8
715.3	711.1	711.7	712.2	712.4	712.8	713.2	713.6
Section 3 - 10,000-GPM pumping station							
706.9	707.2	707.4	707.5	707.7	707.8	708.0	708.7
715.3	710.7	711.3	711.6	712.1	712.3	712.7	713.1
Section 3 - 20,000-GPM pumping station							
706.9	707.1	707.3	707.4	707.6	707.7	707.9	708.[illegible]
715.3	710.3	710.8	711.1	711.5	711.8	712.2	712.[illegible]

(1) Note: Interior pond levels at these river stages remain constant regardless of pumping station size.

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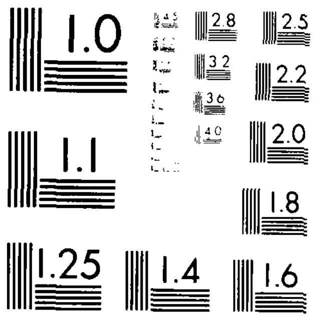

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Table 4C-13 - Interior pond levels assuming gates reopen at 1.0-foot head (cont.)

River stage/freq.	1-Yr.	2.5-Yr.	5-Yr.	10-Yr.	25-Yr.	50-Yr.	100-Yr.
Sections 2 and 3 combined - no pumping							
688.8 (1)	701.0	702.4	703.3	704.0	704.5	709.8	710.3
693.8 (1)	701.0	702.4	703.3	704.0	704.5	709.8	710.3
698.5 (1)	701.0	702.4	703.3	704.0	704.5	709.8	710.3
703.0 (1)	703.3	703.5	703.9	704.2	704.7	710.0	710.4
706.9	707.9	707.9	707.9	707.9	707.9	710.0	710.4
715.3	711.5	712.2	712.6	713.0	713.3	713.9	714.3
Sections 2 and 3 combined - 1,000-GPM pumping station							
706.9	707.9	707.9	707.9	707.9	707.9	710.0	710.4
715.3	711.4	712.1	712.5	712.9	713.3	713.8	714.2
Sections 2 and 3 combined - 6,000-GPM pumping station							
706.9	707.9	707.9	707.9	707.9	707.9	710.0	710.4
715.3	711.2	711.8	712.2	712.6	712.9	713.4	713.8
Sections 2 and 3 combined - 12,000-GPM pumping station							
706.9	707.9	707.9	707.9	707.9	707.9	710.0	710.4
715.3	711.1	711.6	712.1	712.3	712.7	713.1	713.5

(1) Note: Interior pond levels at these river stages remain constant regardless of pumping station size.

Table 4C-13 - Interior pond levels assuming gates reopen at 1.0-foot head (cont.)

River stage/freq.	1-Yr.	2.5-Yr.	5-Yr.	10-Yr.	25-Yr.	50-Yr.	100-Yr.
Section 4 - no pumping							
688.0	705.8	707.1	708.1	709.3	710.3	711.3	713.1
694.0	705.8	707.1	708.1	709.3	710.3	711.3	713.1
698.6	705.8	707.1	708.1	709.3	710.3	711.3	713.1
703.4	705.8	707.1	708.1	709.3	710.3	711.3	713.1
706.8	707.8	707.8	708.1	709.3	710.3	711.3	713.1
714.7	715.1	715.4	715.5	715.7	715.7	715.7	715.7
Courthouse Lake - no pumping							
	704.1	704.3	704.4	704.6	704.8	704.9	705.1

Table 4C-14 - Water levels produced during gravity conditions

Area	50-year elevation	100-year elevation	SPS elevation
Section 1	714.2	714.6	715.3
Section 2	705.7	706.4	706.8
Section 3	705.7	706.5	706.7
Section 2 and 3 combined(1)	709.8	710.3	710.5
Section 4	711.3	713.1	715.3
Courthouse Lake	704.9	705.1	706.3

(1) Single 108-inch gravity outlet.

Table 4C-15 - Water level exceedence probabilities assuming no seepage

Pool level	Index river stage Duration 688.8 0.50	693.8 0.218	698.5 0.157	703.0 0.0734	706.9 0.0422	715.3 0.0094	Chance of exceedence in events per year	Return period of events in years	Damage in dollars
Section 1 - no pumping									
712	1	1	1	1	1	1	1.0	1.0	0
712.5	1	1	1	1	1	1	1.0	1.0	0
713	.27	.27	.27	.27	.27	1	0.28	3.6	0
714	.03	.03	.03	.03	.03	1	0.04	25.6	0
715	.005	.005	.005	.005	.005	1	.014	70.0	0
716	.0001	.0001	.0001	.0001	.0001	1	.009	105.3	0
716.5						.04	.0004	2670	0
717						.008	.00008	13298	0

Table 4C-15 - Water level exceedence probabilities assuming no seepage

Pool level	Index river stage / Duration: 688.8 / 0.50	693.8 / 0.218	698.5 / 0.157	703.0 / 0.0734	706.9 / 0.0422	715.3 / 0.0094	Chance of exceedence in events per year	Return period of events in years	Damage in dollars
Section 2 - no pumping									
701	1	1	1	1	1	1	1.0	1.0	0
702	.985	.985	.985	1	1	1	0.99	1.0	0
703	.50	.50	.50	1	1	1	0.56	1.8	0
704	.15	.15	.15	.15	1	1	0.19	5.2	0
706	.013	.013	.013	.013	1	1	0.06	15.6	0
708					.20	1	0.018	56.1	0
710					.002	1	0.0095	105.4	0
711						1	0.0094	106.4	0
712						.30	0.0028	354.6	130,000
713						.035	.00033	3040	190,000
714						.0045	.00004	23641	260,000
Section 2 - 3,000-GPM pumping station									
701	1	1	1	1	1	1	1.0	1.0	0
702	.985	.985	.985	1	1	1	0.99	1.0	0
703	.50	.50	.50	1	1	1	0.56	1.8	0
704	.15	.15	.15	.15	1	1	0.19	5.2	0
706	.013	.013	.013	.013	1	1	0.06	15.6	0
708					.20	1	0.018	56.1	0
710					.002	1	.0095	105.4	0
711						.95	.0089	112.0	0
712						.04	.00038	2659	130,000
Section 2 - 5,000-GPM pumping station									
700	1	1	1	1	1	1	1.0	1.0	0
700.5	.985	.985	.985	1	1	1	0.99	1.0	0
702	.50	.50	.50	1	1	1	0.56	1.8	0
704	.15	.15	.15	.15	1	1	0.19	5.2	0
706	.013	.013	.013	.013	1	1	0.06	15.6	0
708					.20	1	0.018	56.1	0
710					.002	1	.0095	105.4	0
711						.90	.0085	118.2	0
712						.02	.00019	5319	130,000
Section 2 - 10,000-GPM pumping station									
701	1	1	1	1	1	1	1.0	1.0	0
702	.985	.985	.985	1	1	1	0.99	1.0	0
703	.50	.50	.50	1	1	1	0.56	1.8	0
704	.15	.15	.15	.15	1	1	0.19	5.2	0
706	.013	.013	.013	.013	1	1	0.06	15.6	0
708					.20	1	0.018	56.1	0
710					.002	1	.0095	105.4	0
711						.40	.0038	266.0	0
712						.01	.00009	10638	130,000

Table 4C-15 - Water level exceedence probabilities assuming no seepage

Pool level	Index river stage / Duration: 688.8 / 0.50	693.8 / 0.218	698.5 / 0.157	703.0 / 0.0734	706.9 / 0.0422	715.3 / 0.0094	Chance of exceedence in events per year	Return period of events in years	Damage in dollars
Section 3 - no pumping									
702	1	1	1	1	1	1	1.0	1.0	0
703	.90	.90	.90	1	1	1	0.91	1.1	0
704	.20	.20	.20	.20	1	1	0.24	4.1	0
706	.016	.016	.016	.016	1	1	0.07	15.0	0
708					1	1	0.05	19.3	0
709					.01	1	.0098	101.8	0
711					.0015	1	.0094	105.7	170,000
712						.75	.0071	141.8	240,000
713						.22	.0021	483.6	340,000
714						.05	.00047	2128	520,000
715						.007	.00007	15198	660,000
Section 3 - 5,000-GPM pumping station									
702	1	1	1	1	1	1	1.0	1.0	0
703	.90	.90	.90	1	1	1	0.91	1.1	0
704	.20	.20	.20	.20	1	1	0.24	4.1	0
706	.016	.016	.016	.016	1	1	0.07	15.0	0
708					.04	1	0.011	90.2	0
709					.006	1	.0097	103.6	0
711						1	.0094	106.4	170,000
712						.20	.0019	531.9	240,000
713						.03	.00028	3546	340,000
Section 3 - 10,000-GPM pumping station									
702	1	1	1	1	1	1	1.0	1.0	0
703	.90	.90	.90	1	1	1	0.91	1.1	0
704	.20	.20	.20	.20	1	1	0.24	4.1	0
706	.016	.016	.016	.016	1	1	0.07	15.0	0
708					.04	1	0.011	90.2	0
709					.006	1	.0097	103.6	0
711						.97	.0091	109.8	170,000
712						.08	.0008	1330	240,000
Section 3 - 20,000-GPM pumping station									
702	1	1	1	1	1	1	1.0	1.0	0
703	.90	.90	.90	1	1	1	0.91	1.1	0
704	.20	.20	.20	.20	1	1	0.24	4.1	0
706	.016	.016	.016	.016	1	1	0.07	15.0	0
708					.025	1	0.010	95.6	0
709					.005	1	.0096	104.0	0
711						.22	.0021	476.1	170,000
712						.03	.00028	3546	240,000

Table 4C-15 - Water level exceedence probabilities assuming no seepage

Pool level	Index river stage / Duration: 688.8 / 0.50	693.8 / 0.218	698.5 / 0.157	703.0 / 0.0734	706.9 / 0.0422	715.3 / 0.0094	Chance of exceedence in events per year	Return period of events in years	Damage in dollars
Sections 2 and 3 combined - no pumping									
700	1	1	1	1	1	1	1.0	1.0	0
702	.60	.60	.60	1	1	1	0.65	1.5	0
704	.08	.08	.08	.16	1	1	0.13	7.5	0
706	.03	.03	.03	.035	1	1	0.08	12.4	0
708	.025	.025	.025	.03	.03	1	0.03	28.8	0
710	.017	.017	.017	.02	.02	1	.027	37.6	0
711						1	.0094	106.3	170,000
712						.50	.0047	212.8	360,000
714						.015	.00014	7092	780,000
Sections 2 and 3 combined - 1,000-GPM pumping station									
700	1	1	1	1	1	1	1.0	1.0	0
702	.60	.60	.60	1	1	1	0.65	1.5	0
704	.08	.08	.08	.16	1	1	0.13	7.5	0
706	.03	.03	.03	.035	1	1	0.08	12.4	0
708	.025	.025	.025	.03	.03	1	0.03	28.8	0
710	.017	.017	.017	.02	.02	1	0.027	37.6	0
711						1	.0094	106.3	170,000
712						.36	.0034	295.5	360,000
714						.015	.00014	7092	780,000
Sections 2 and 3 combined - 6,000-GPM pumping station									
700	1	1	1	1	1	1	1.0	1.0	0
702	.60	.60	.60	1	1	1	0.65	1.5	0
704	.08	.08	.08	.16	1	1	0.13	7.5	0
706	.03	.03	.03	.035	1	1	0.08	12.4	0
708	.025	.025	.025	.03	.03	1	0.03	28.8	0
710	.017	.017	.017	.02	.02	1	.027	37.6	0
711						1	.0094	106.3	170,000
712						.26	.0024	409.2	360,000
714						.005	.00005	21276	780,000
Sections 2 and 3 combined - 12,000 GPM pumping station									
700	1	1	1	1	1	1	1.0	1.0	0
702	.60	.60	.60	1	1	1	0.65	1.5	0
704	.08	.08	.08	.16	1	1	0.13	7.5	0
706	.03	.03	.03	.035	1	1	0.08	12.4	0
708	.025	.025	.025	.03	.03	1	0.03	28.8	0
710	.017	.017	.017	.02	.02	1	.027	37.6	0
711						1	.0094	106.3	170,000
712						.17	.0016	625.8	360,000
714						.004	.00004	26596	780,000

Table 4C-15 - Water level exceedence probabilities assuming no seepage

Pool level	Index river stage 688.8 Duration 0.50	693.8 0.218	698.5 0.157	703.0 0.0734	706.9 0.0422	715.3 0.0094	Chance of exceedence in events per year	Return period of events in years	Damage in dollars
Section 4 - no pumping									
704	1	1	1	1	1	1	1.0	1.0	0
706	.88	.88	.88	.88	1	1	.89	1.1	0
708	.22	.22	.22	.22	.23	1	.23	4.4	0
710	.055	.055	.055	.055	.055	1	.06	15.7	0
712	.016	.016	.016	.016	.016	1	.03	39.6	0
714	.005	.005	.005	.005	.005	1	.014	69.7	0
715	.0015	.0015	.0015	.0015	.0015	1	.011	91.9	0
715.7						.10	.0009	1064	0

Table 4C-16 - Historic periods of blocked gravity conditions (1961-79)

Period of gate closure (dates)	No. of days	Rainfall	Rainfall excess
Gate closure at elevation 706.0 (sections 2,3,4, and Courthouse Lake)			
2-27 Apr 1962	26	0.74	0.52
8 Apr - 5 May 1965	28	2.58	1.81
6-11 Apr 1967	6	1.42	0.99
21-23 Jun 1967	3	1.04	0.73
29 Mar - 10 May 1969	43	2.18	1.53
20 Mar - 9 Apr 1971	21	0.38	0.27
16-24 Mar 1973	9	0.42	0.29
28 Apr - 9 May 1975	12	1.14	0.80
1 Apr - 5 May 1979	35	1.67	1.17
Gate closure at elevation 712.0 (section 1)			
4-7 Apr 1962	4	0.03	0.02
9-23 Apr 1965	15	1.46	1.02
9-24 Apr 1969	16	0.74	0.52

Table 4C-17 - One-percent and standard project storm pond level data all-year (gravity and blocked gravity) conditions

Section	Preproject conditions				Postproject conditions			
	100-year		SPS		100-year		SPS	
	Elevation	Damage	Elevation	Damage	Elevation	Damage	Elevation	Damage
Section 1	715.7	0	717	0	715.7	0	717	0
Section 2	710	0	713.6	$230,000	710	0	712	$130,000
Section 3	709.5	0	715	610,000	709.5	0	713.5	420,000
Section 4	723.2	$810,000	731.1	1,000,000+	715	0	715.8	0
Courthouse Lake	705.1	0	706.0	0	705.1	0	706.3	0

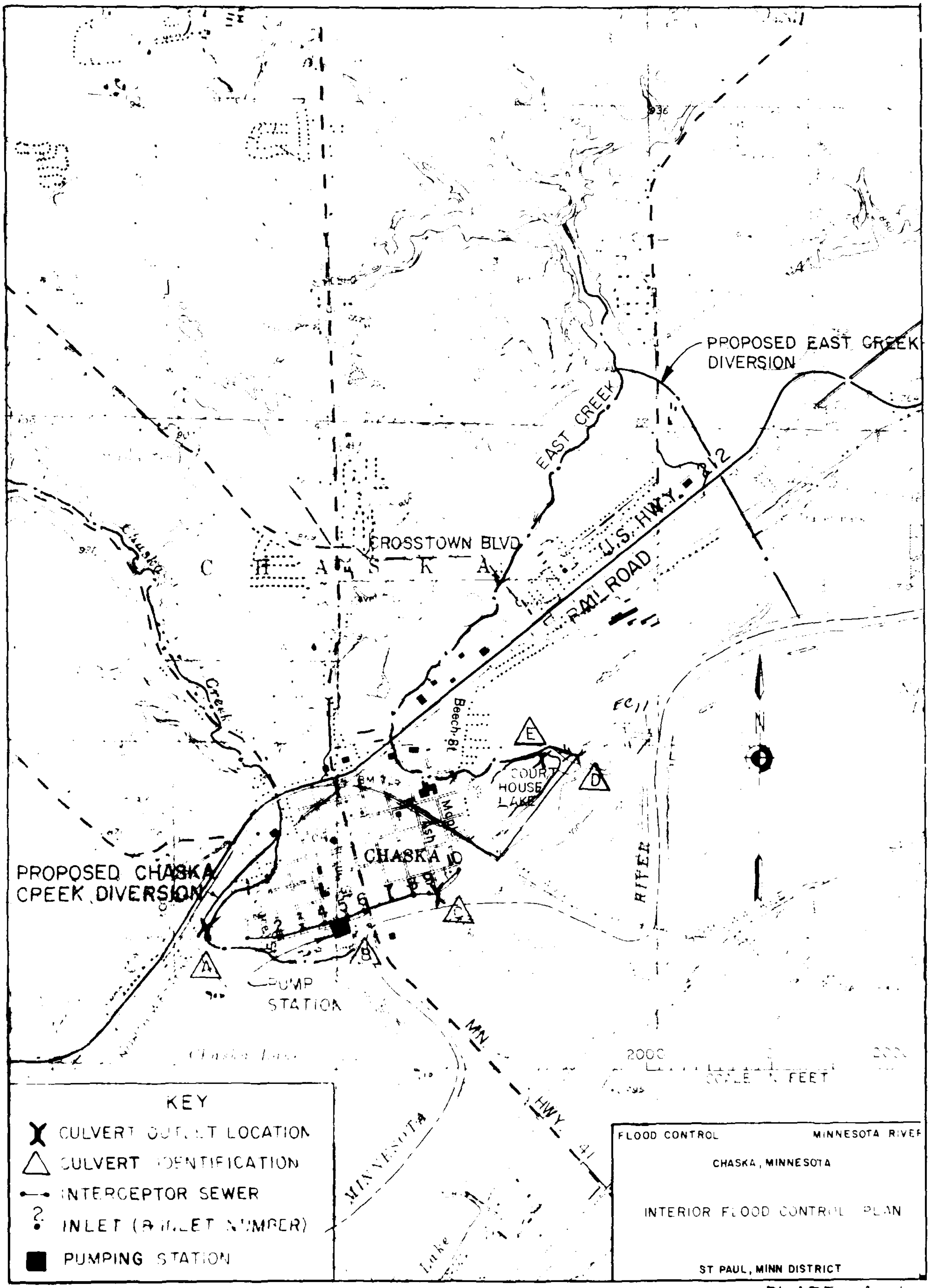
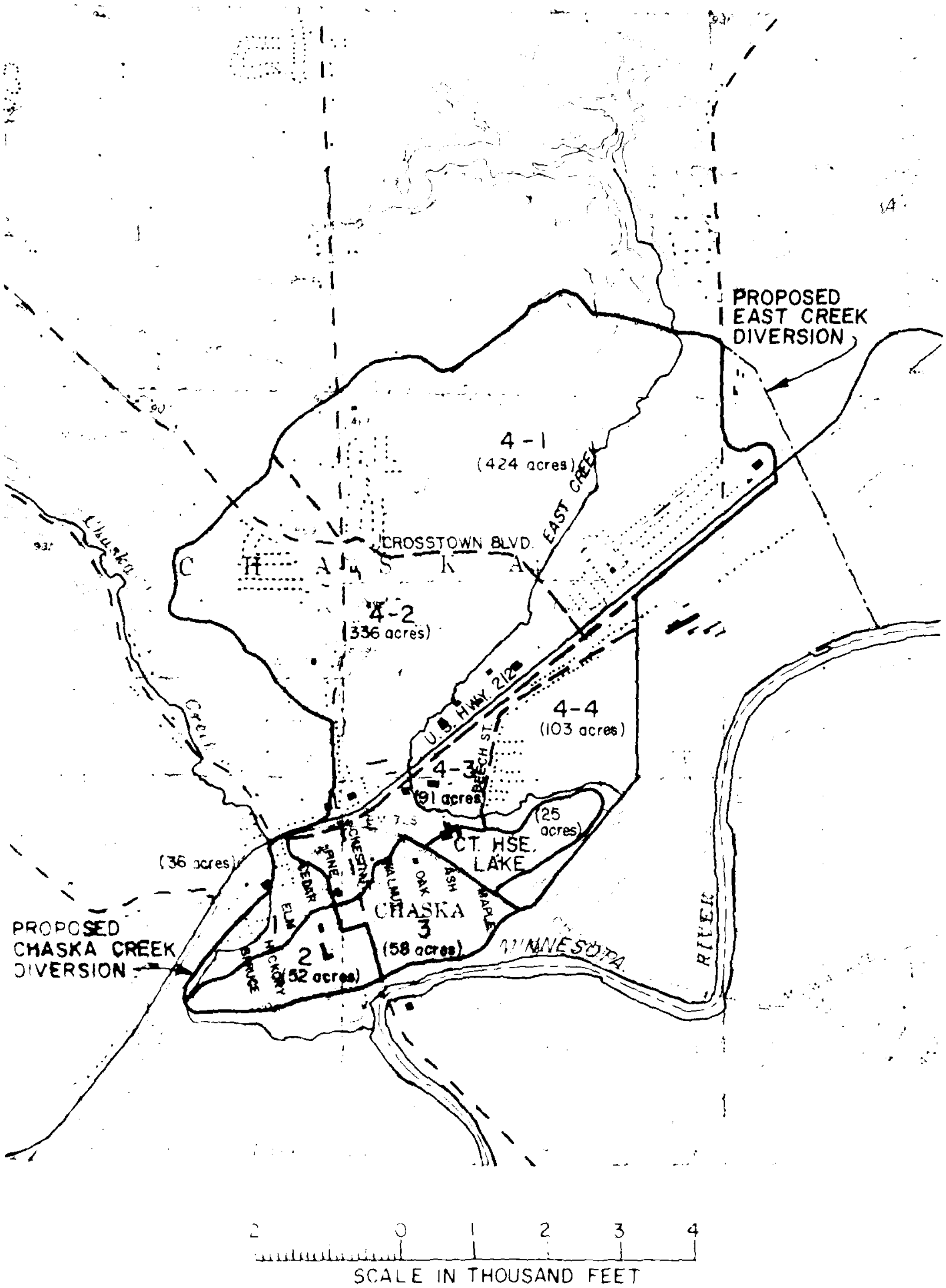

PROPOSED EAST CREEK
DIVERSION
EAST CREEK
U.S. HWY. 212
CROSSTOWN BLVD
C H A S K A
FARM ROAD
Beech St
COURT HOUSE LAKE
CHASKA
PROPOSED CHASKA
CREEK DIVERSION
PUMP
STATION
RIVER
MN HWY 41
MINNESOTA
N
2000
SCALE IN FEET
A
B
C
D
E
KEY
CULVERT OUTLET LOCATION
CULVERT IDENTIFICATION
INTERCEPTOR SEWER
INLET (& INLET NUMBER)
PUMPING STATION
FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
INTERIOR FLOOD CONTROL PLAN
ST PAUL, MINN DISTRICT

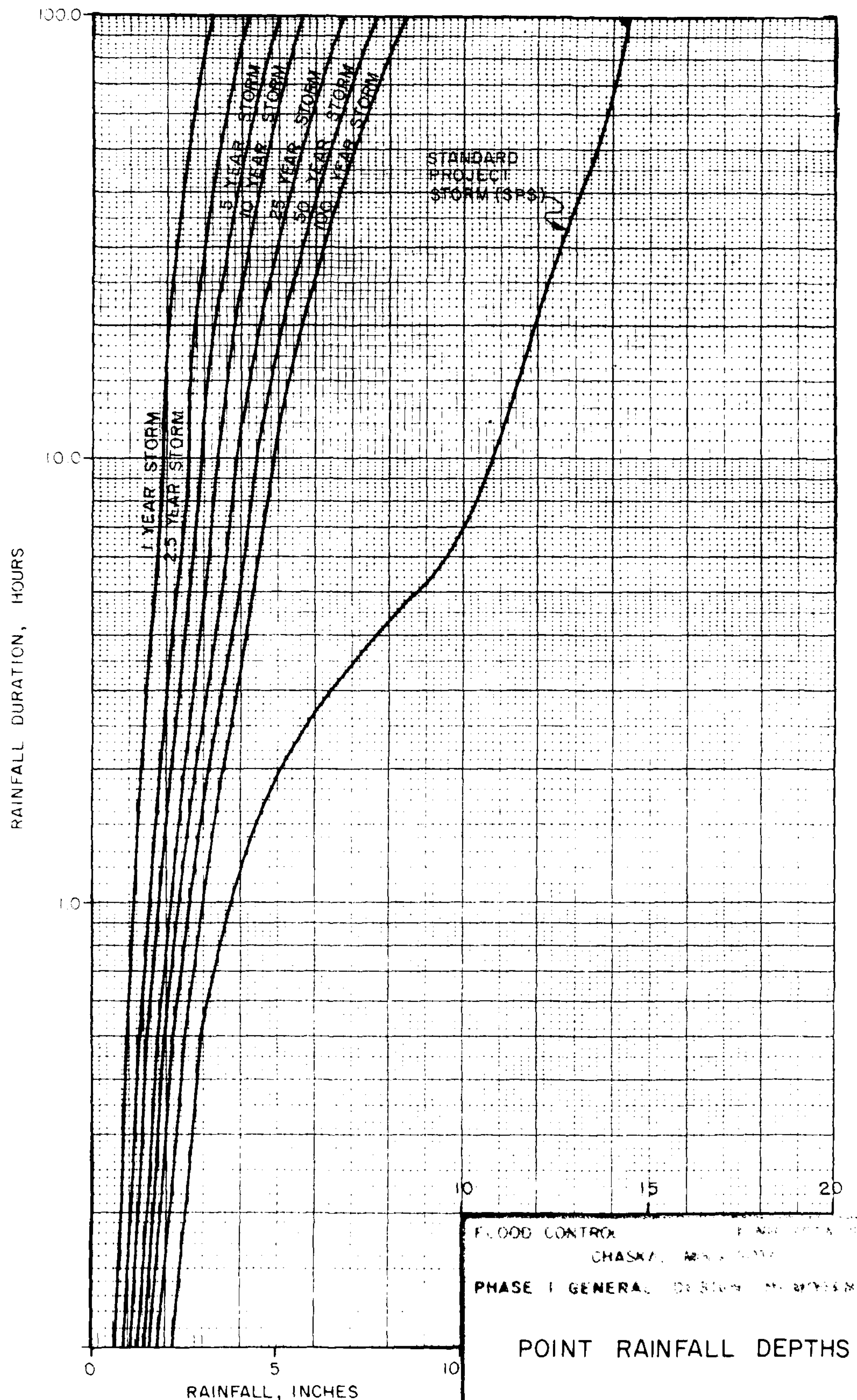
PLATE 40-1



CHASKA, MN.

CONTRIBUTING WATERSHEDS

PLATE 4C-2



FLOOD CONTROL

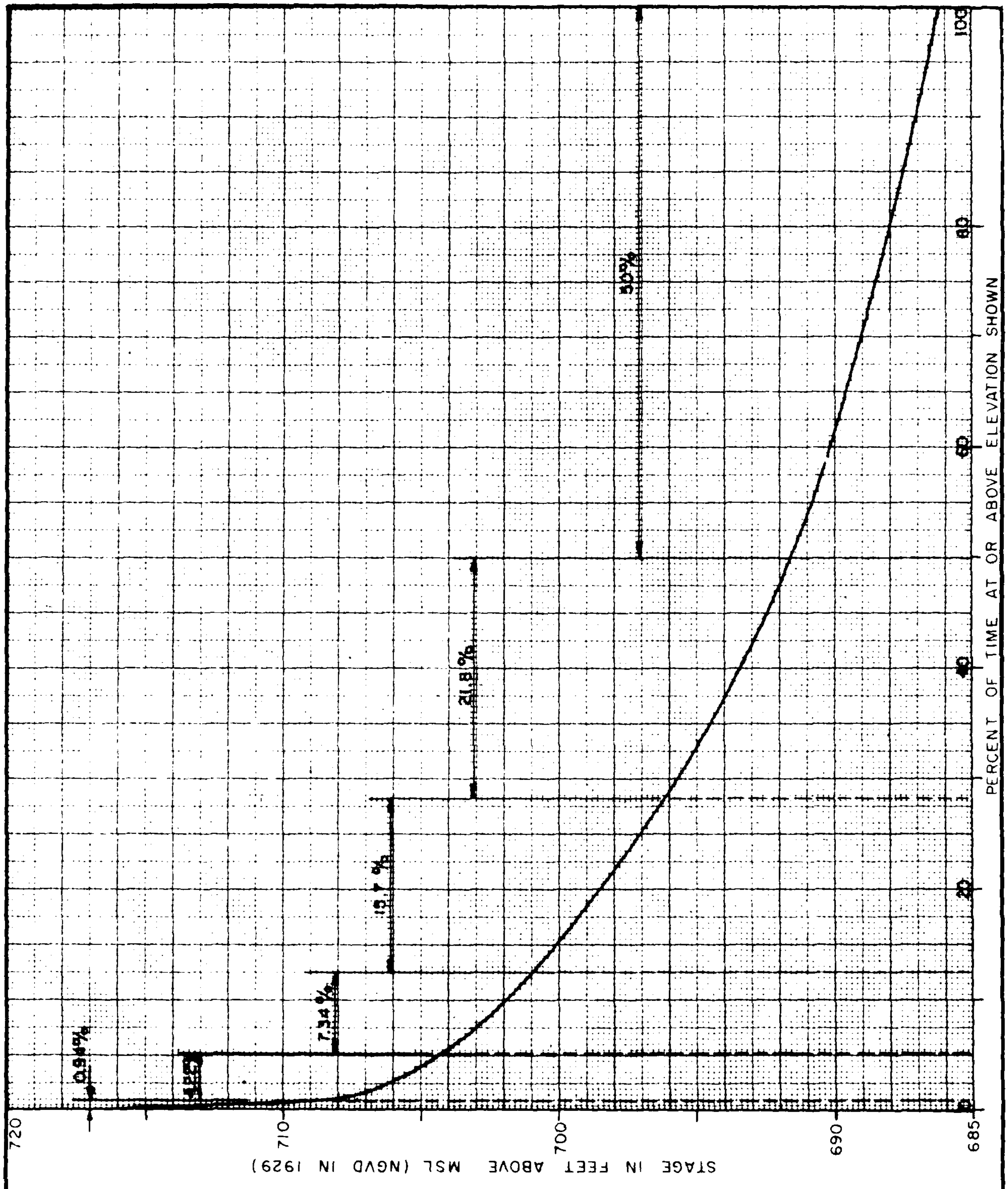
CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

POINT RAINFALL DEPTHS

ST. PAUL DISTRICT

PLATE 4C-3

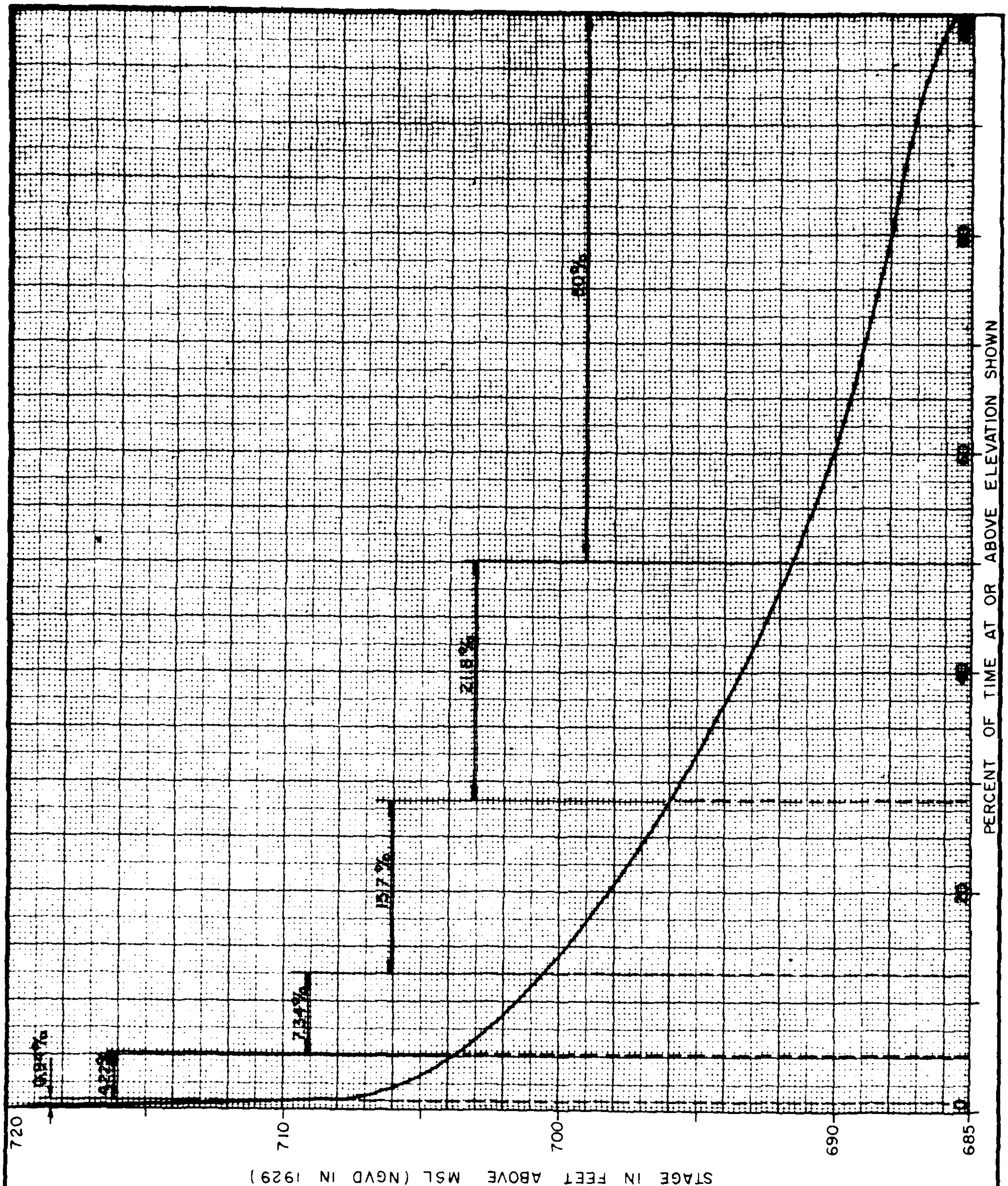


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

STAGE - DURATION CURVE
MINNESOTA RIVER at
CHASKA CREEK

ST. PAUL DISTRICT



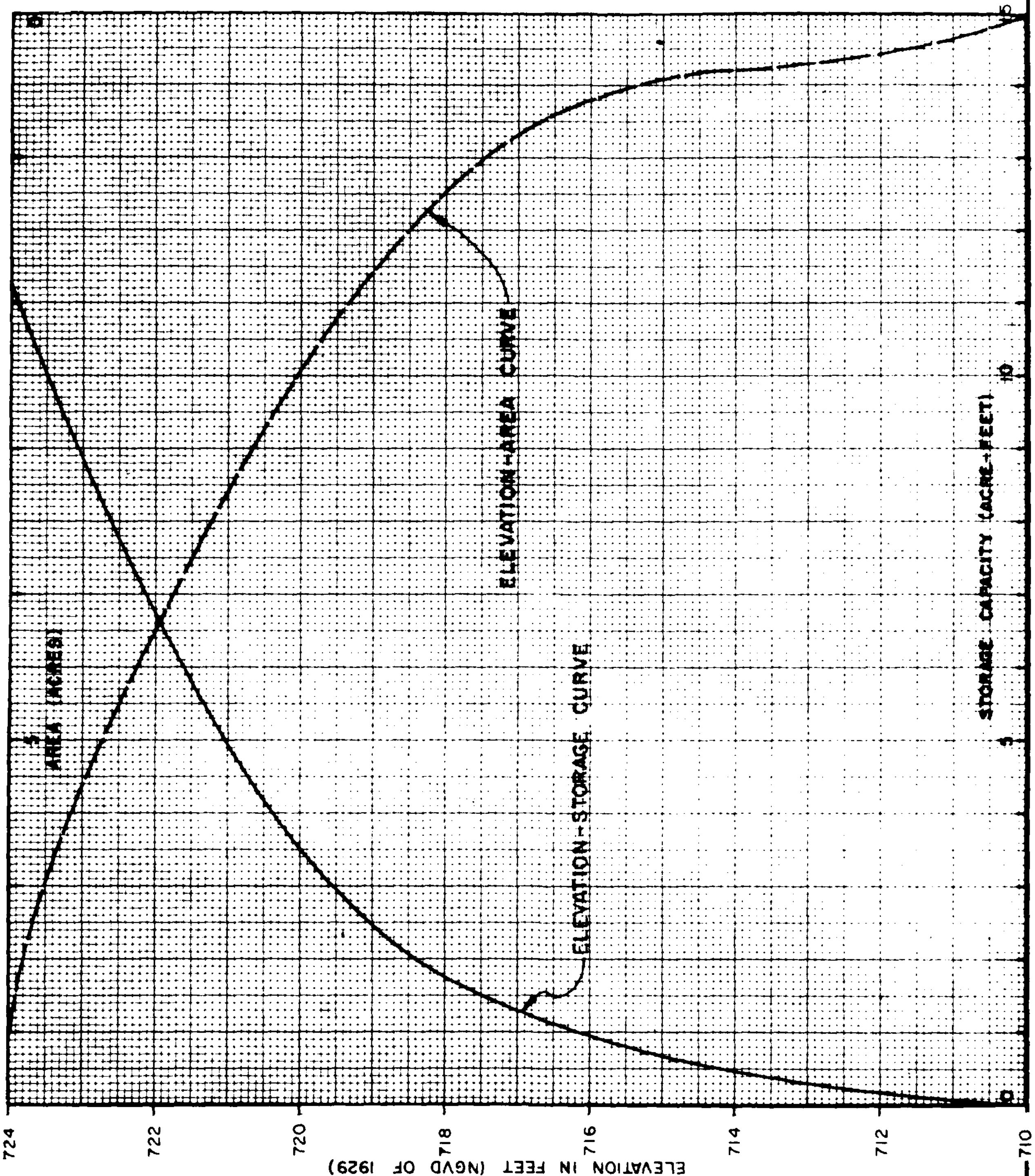
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

STAGE-DURATION CURVE
MINNESOTA RIVER at
EAST CREEK

ST. PAUL DISTRICT

PLATE 4C-5



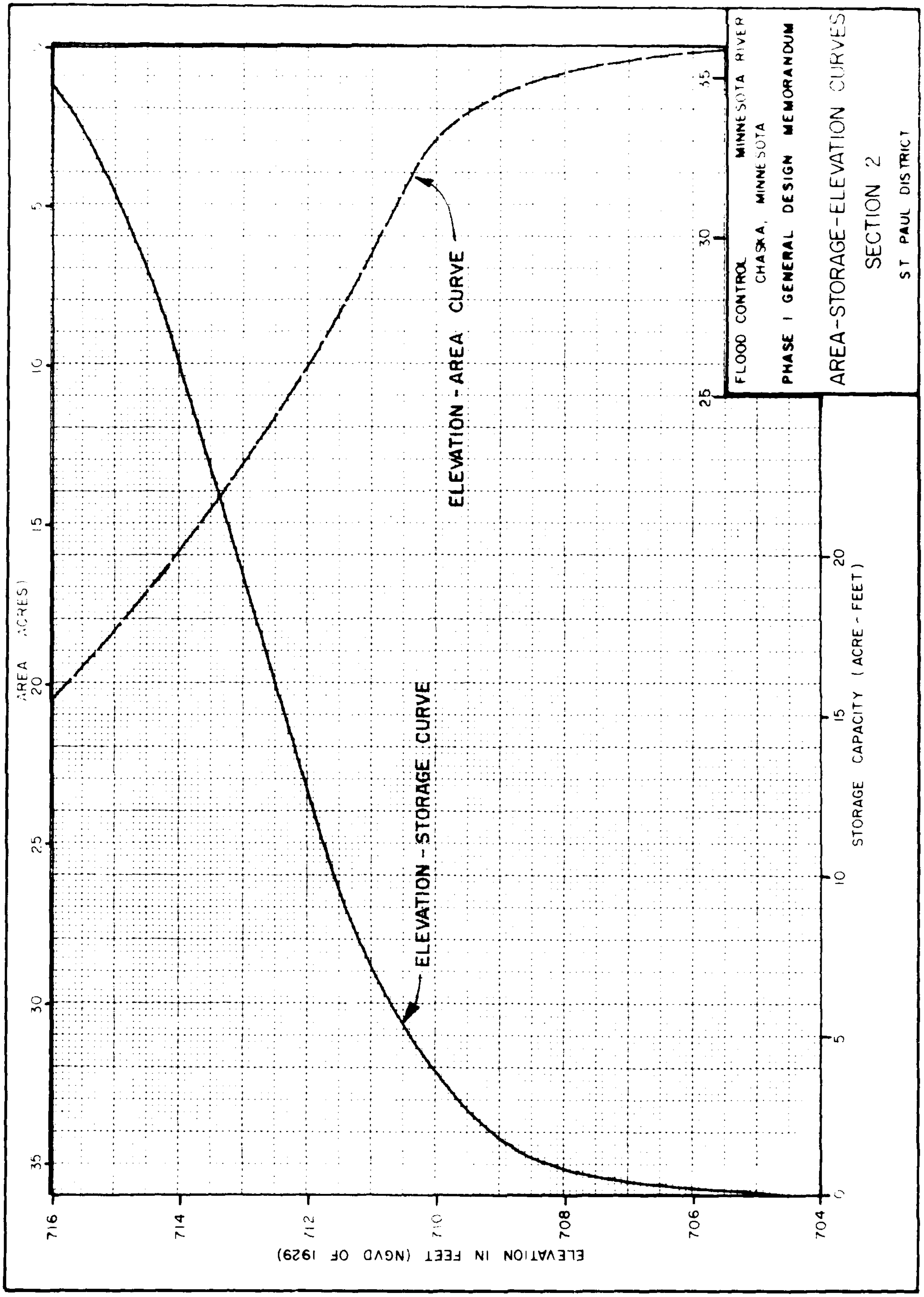
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

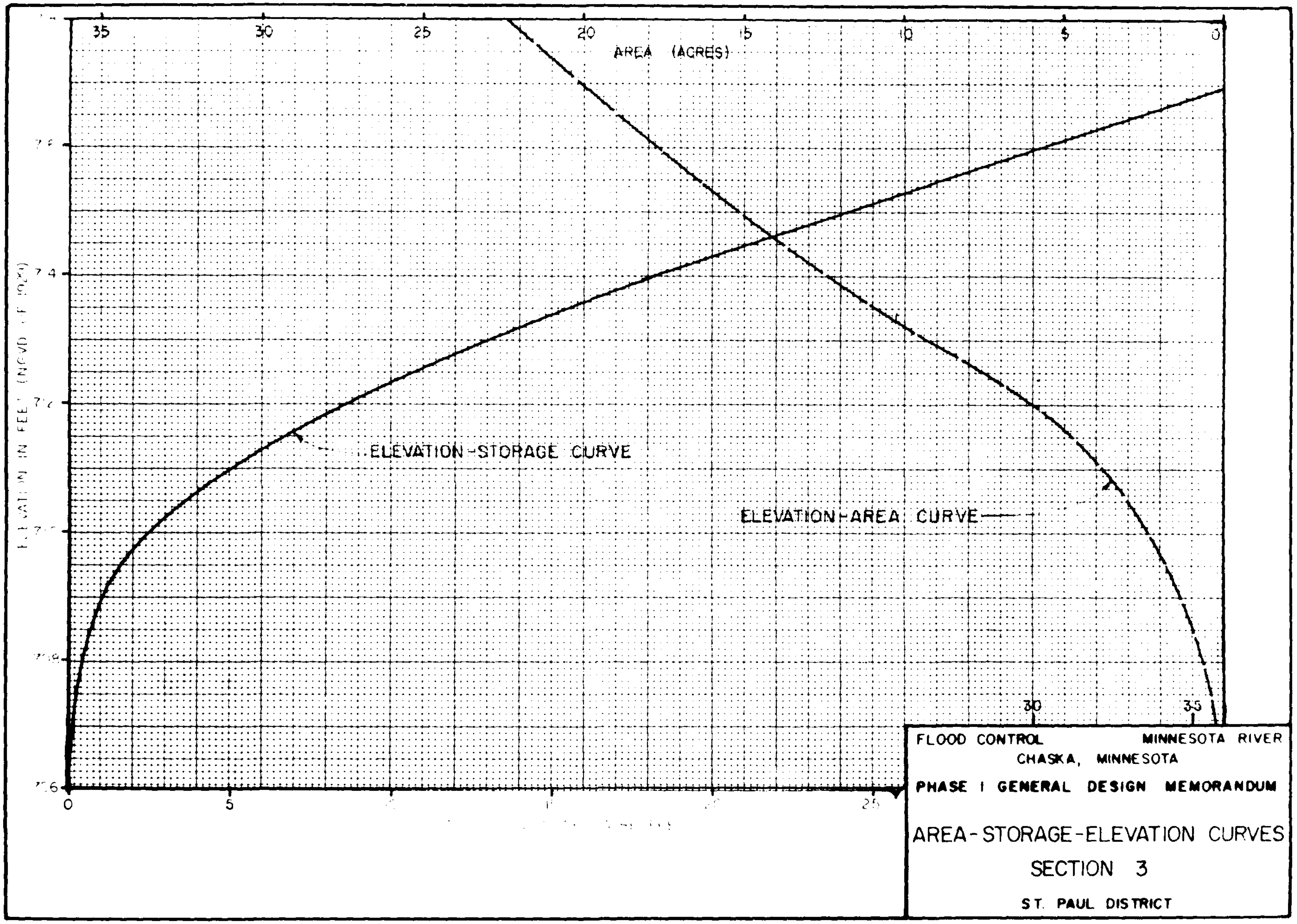
PHASE I GENERAL DESIGN MEMORANDUM

AREA-STORAGE-ELEVATION CURVES
SECTION I

ST. PAUL DISTRICT

PLATE 4C-6

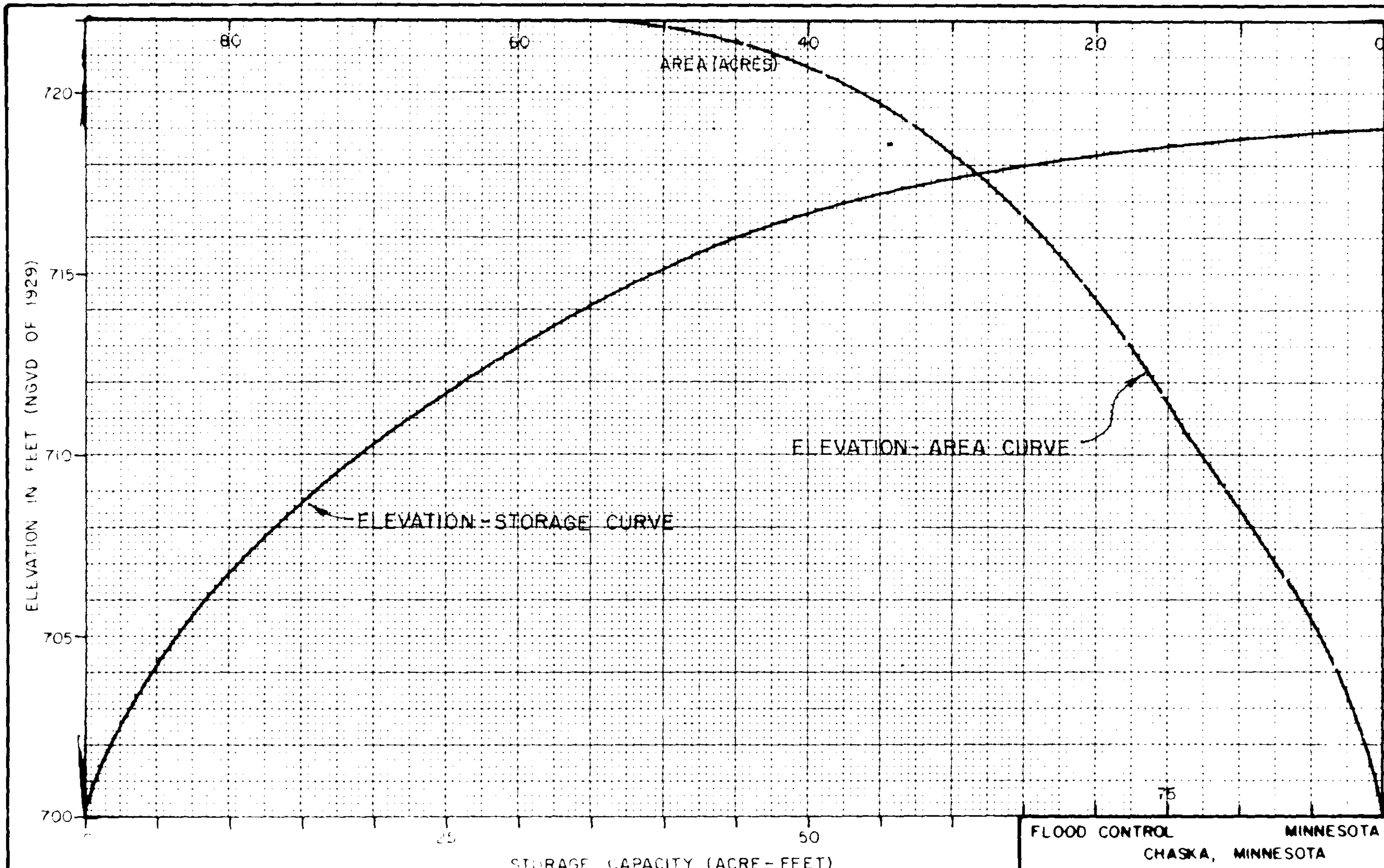

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
AREA-STORAGE-ELEVATION CURVES
SECTION 2
ST PAUL DISTRICT
ELEVATION - AREA CURVE
ELEVATION - STORAGE CURVE
AREA (ACRES)
STORAGE CAPACITY (ACRE - FEET)
ELEVATION IN FEET (NGVD OF 1929)



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

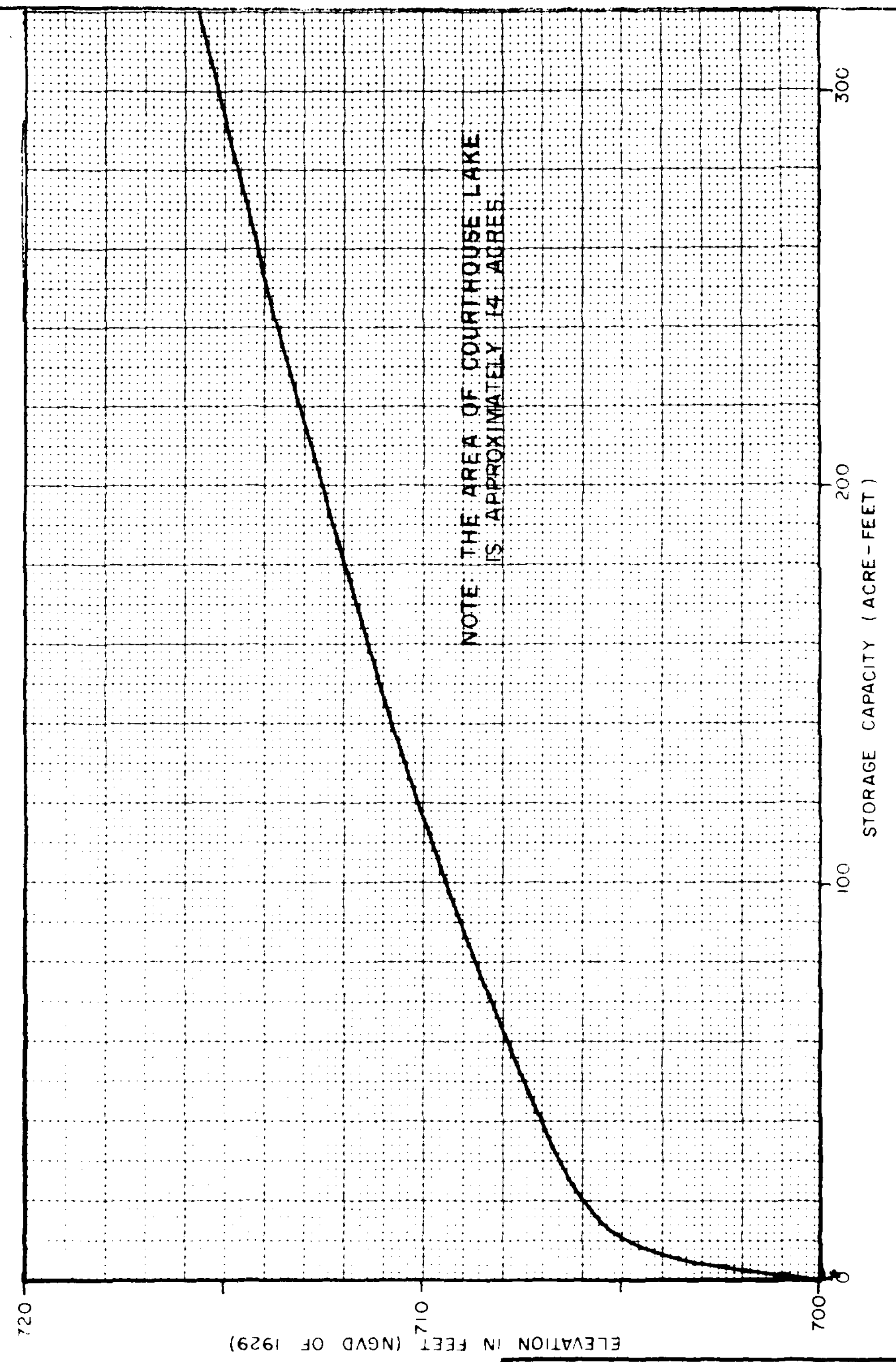
AREA-STORAGE-ELEVATION CURVES
SECTION 3
ST. PAUL DISTRICT

PLATE 4C-8



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

AREA-STORAGE-ELEVATION CURVES
SECTION 4
ST. PAUL DISTRICT

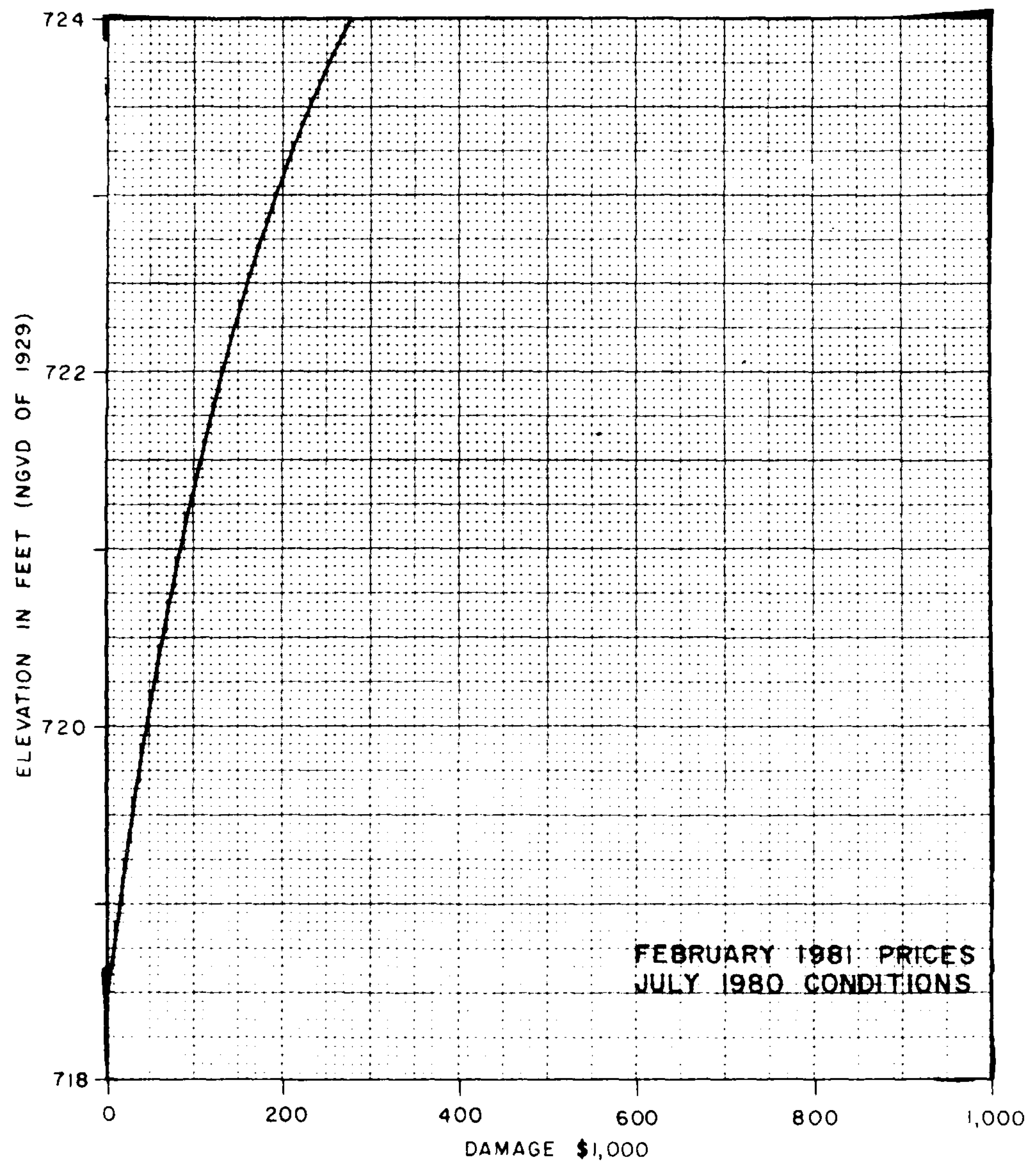


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

STORAGE-ELEVATION CURVE
COURTHOUSE LAKE

ST PAUL DISTRICT

PLATE 4C-10

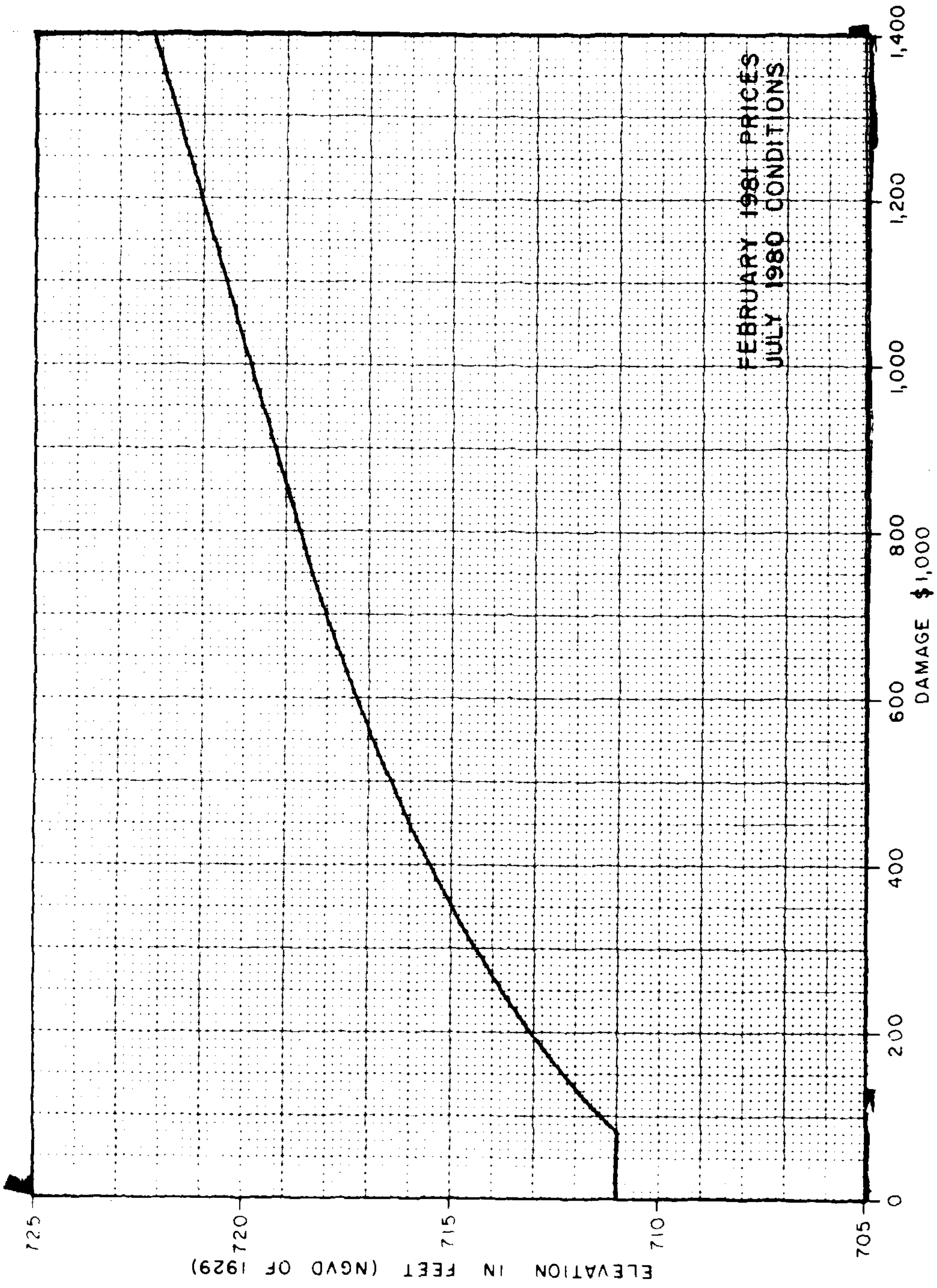


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

DAMAGE-ELEVATION CURVE
SECTION I

ST PAUL DISTRICT

PLATE 4C-11

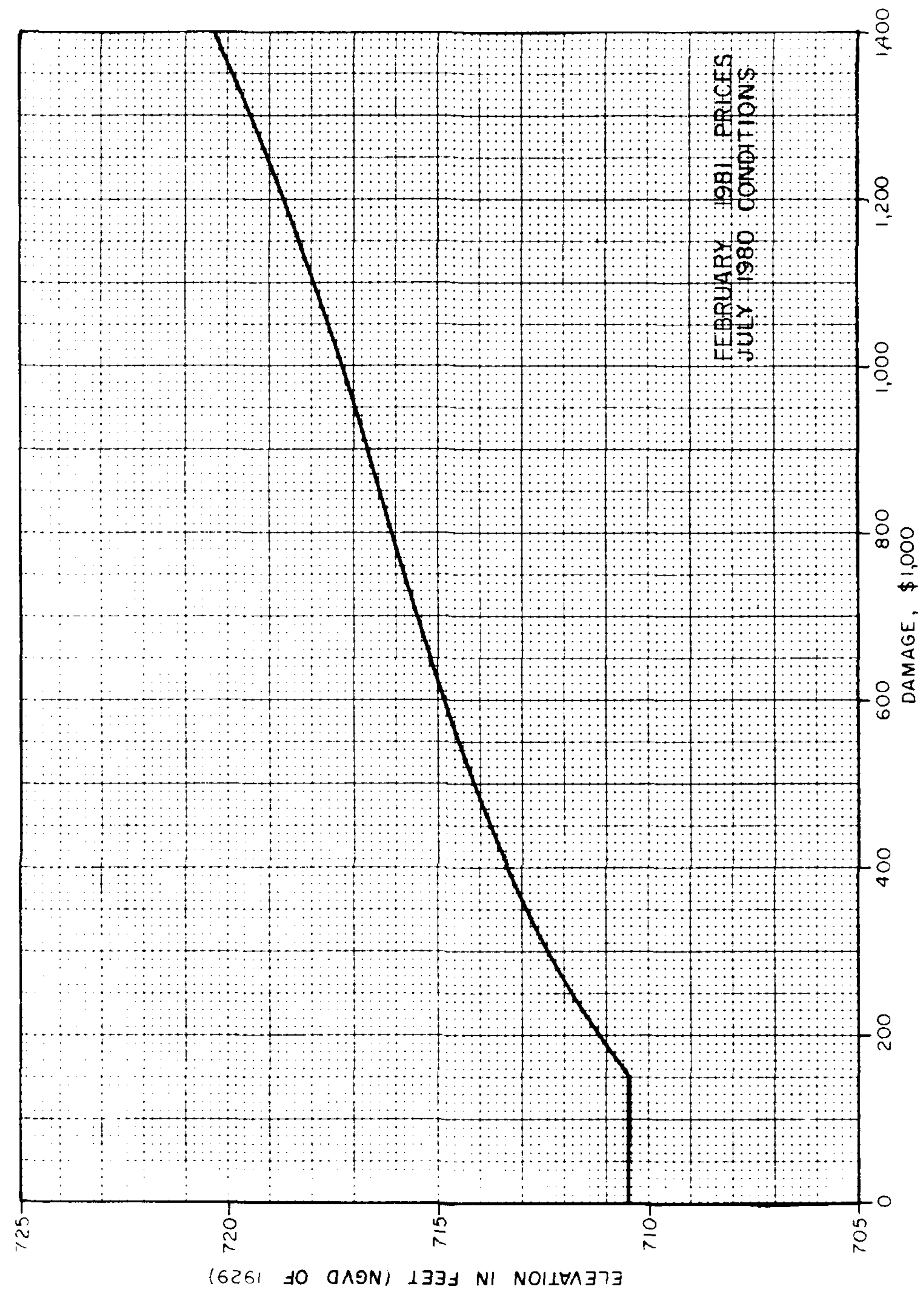


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

DAMAGE-ELEVATION CURVE
SECTION 2

ST PAUL DISTRICT

PLATE 4C-12

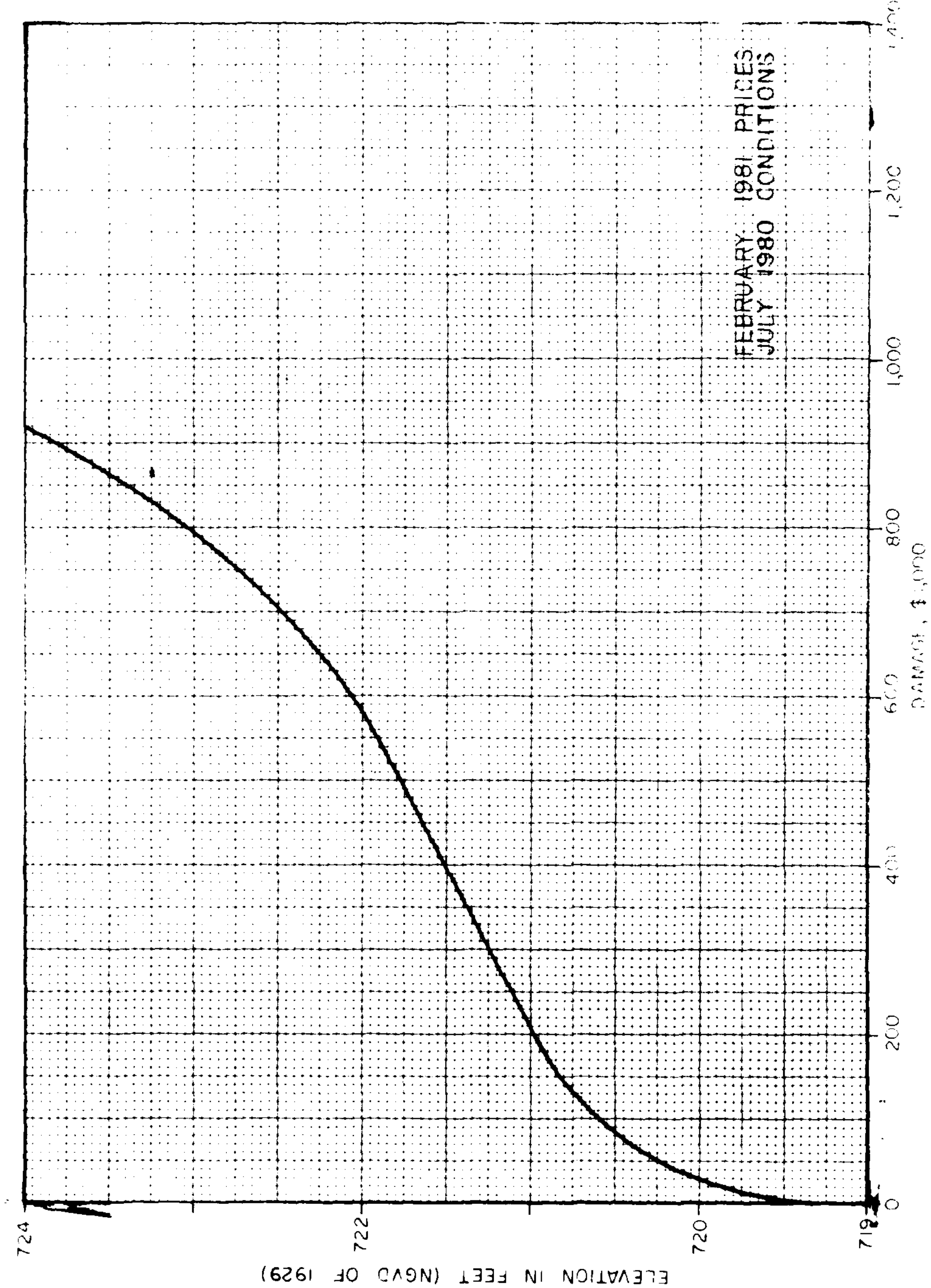


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

DAMAGE-ELEVATION CURVE
SECTION 3

ST. PAUL DISTRICT



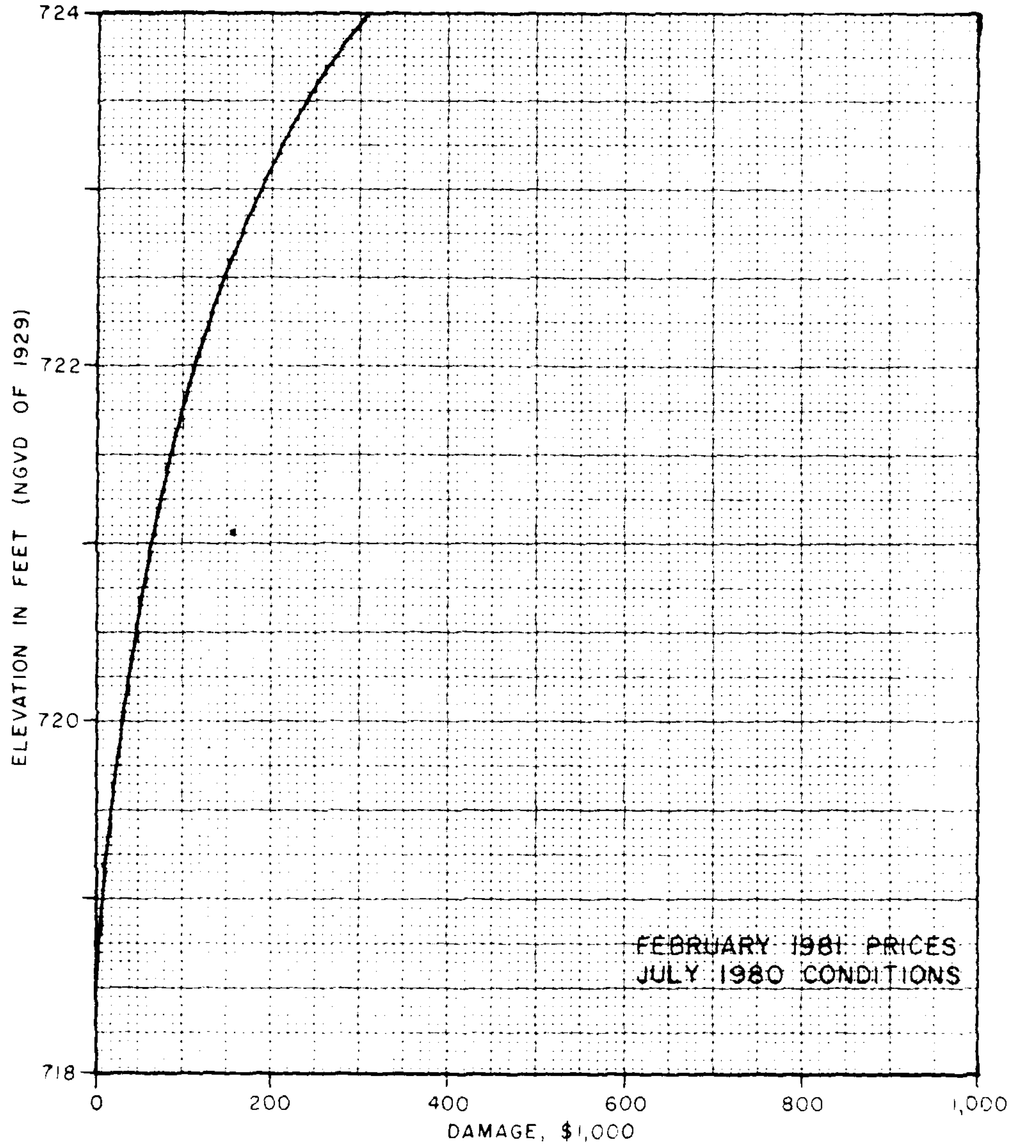
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

DAMAGE-ELEVATION CURVE
SECTION 4

ST PAUL DISTRICT

PLATE 4C-14

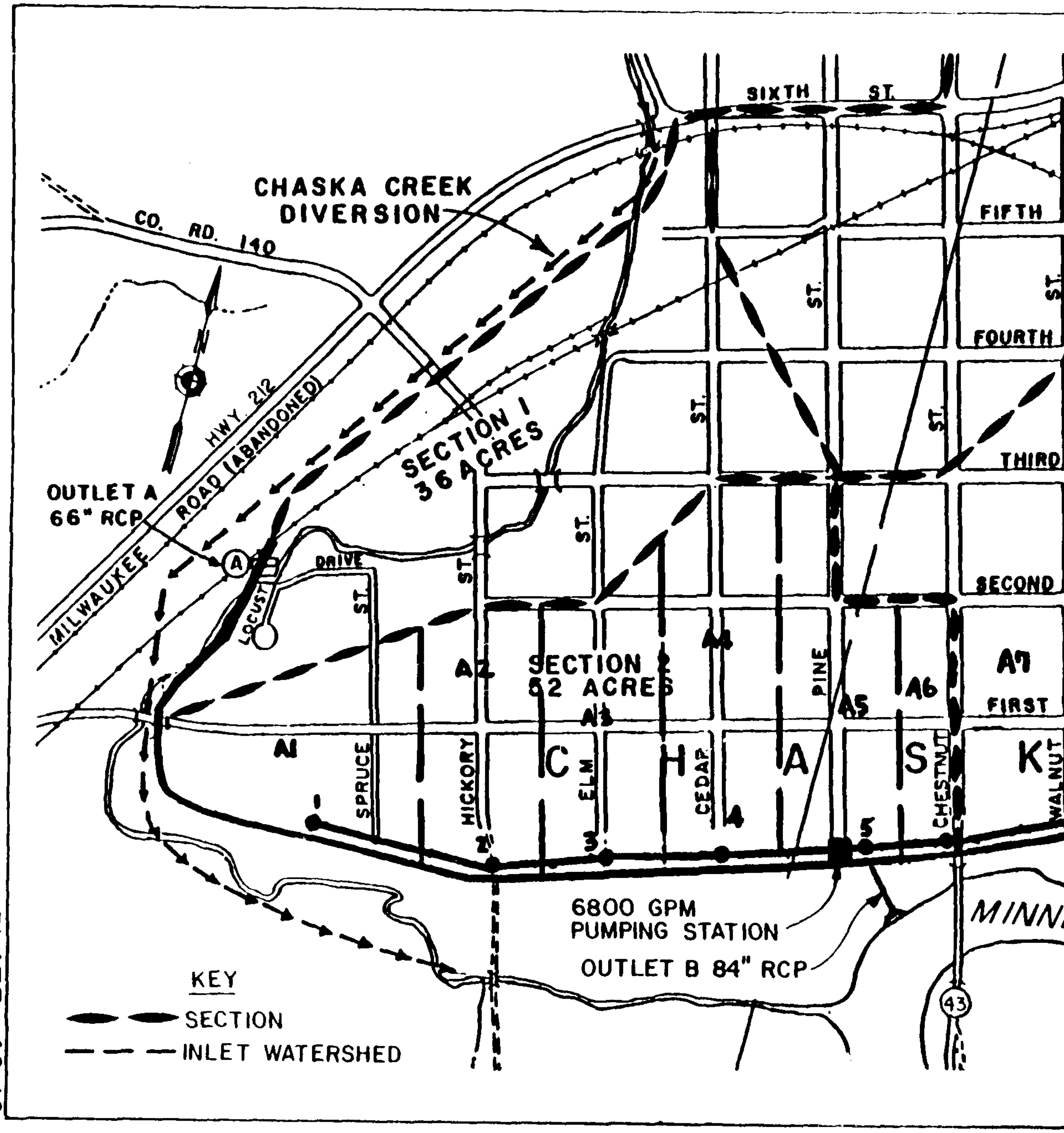


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

DAMAGE-ELEVATION CURVE
COURTHOUSE LAKE SECTION

ST. PAUL [illegible]

4C-15



INTERCEPTOR SEWER INLET WATERSHEDS
CHASKA, MN.

PLATE 4C-16

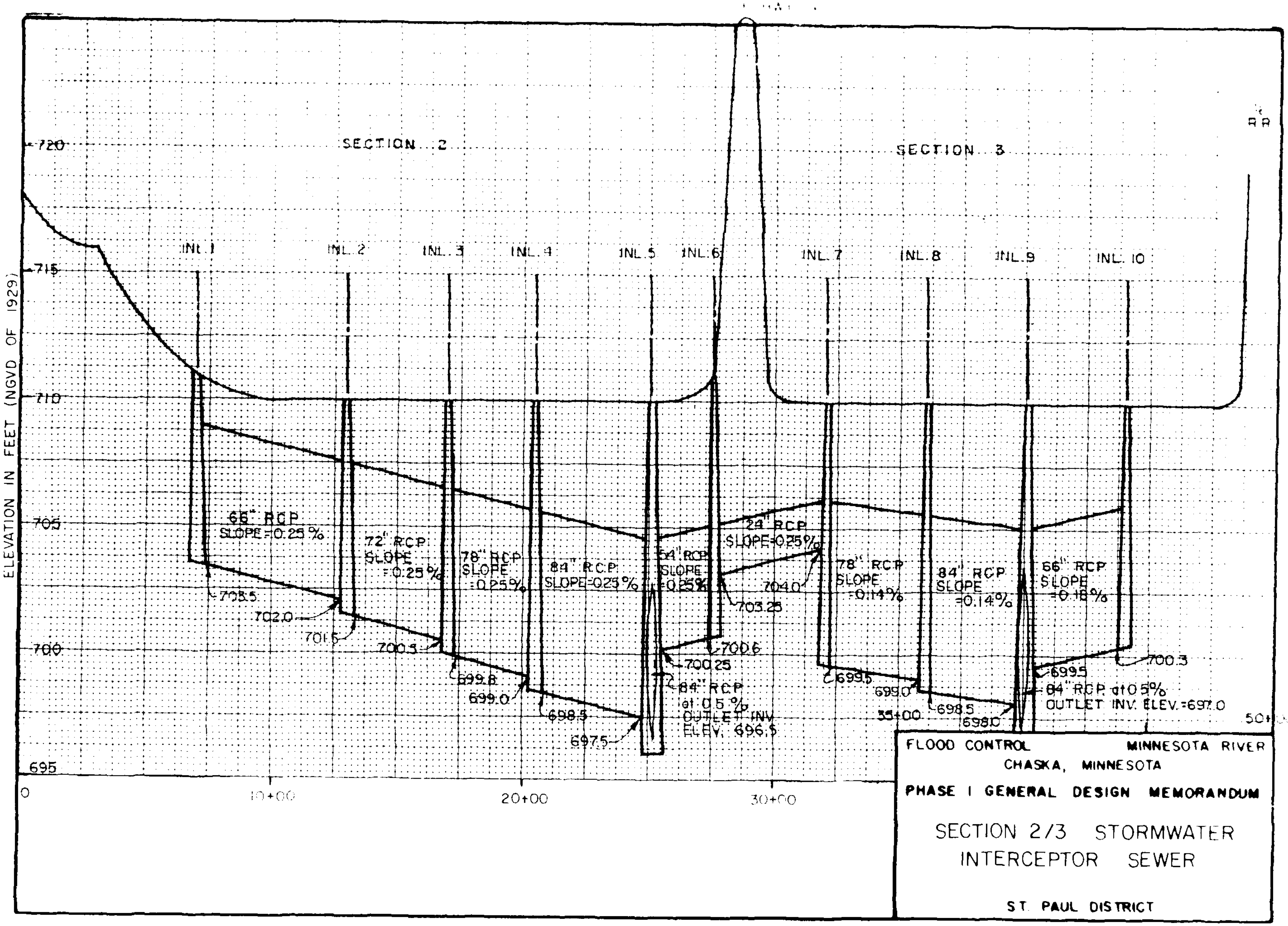
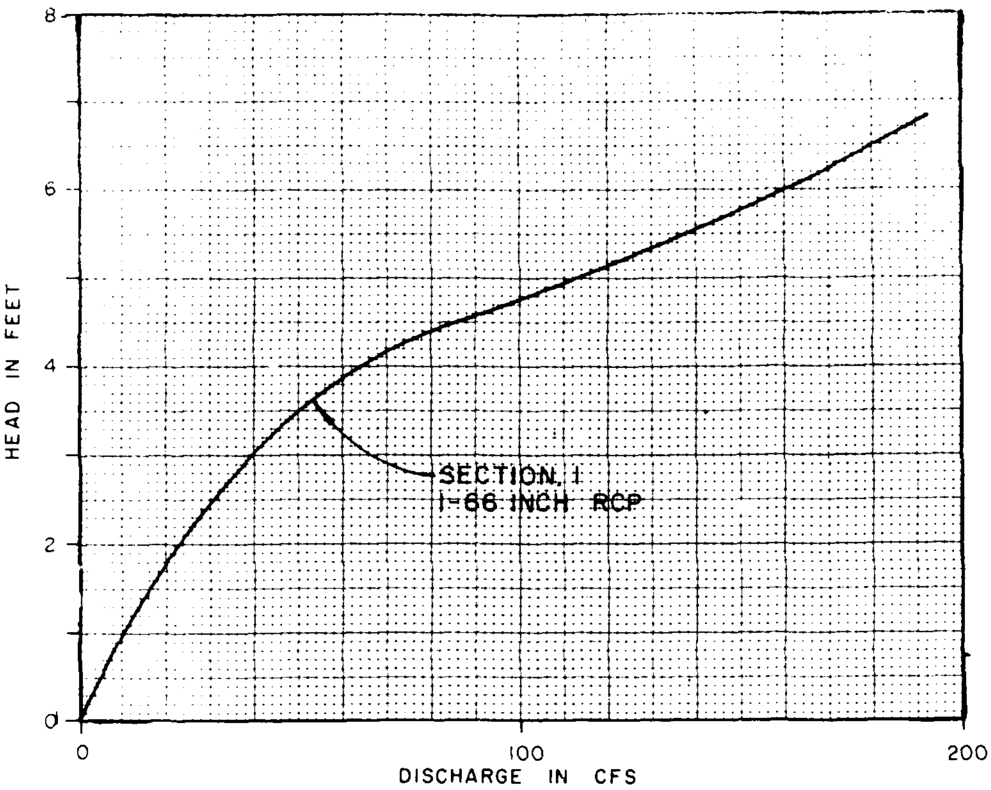
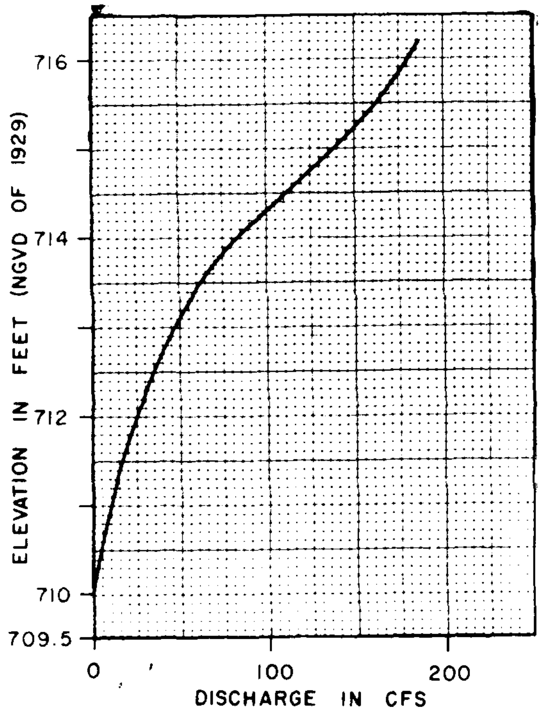

SECTION 2
SECTION 3
RR
INL. 1
INL. 2
INL. 3
INL. 4
INL. 5
INL. 6
INL. 7
INL. 8
INL. 9
INL. 10
720
715
710
705
700
695
ELEVATION IN FEET (NGVD OF 1929)
0
10+00
20+00
30+00
35+00
50+00
66" RCP SLOPE=0.25%
72" RCP SLOPE =0.25%
78" RCP SLOPE =0.25%
84" RCP SLOPE=0.25%
54" RCP SLOPE =0.25%
24" RCP SLOPE=0.25%
78" RCP SLOPE =0.14%
84" RCP SLOPE =0.14%
66" RCP SLOPE =0.18%
703.5
702.0
701.5
700.5
699.8
699.0
698.5
697.5
700.25
700.6
703.25
704.0
84" RCP at 0.5% OUTLET INV ELEV. 696.5
699.5
699.0
698.5
698.0
699.5
700.3
84" RCP at 0.5% OUTLET INV. ELEV.=697.0
FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
SECTION 2/3 STORMWATER
INTERCEPTOR SEWER
ST. PAUL DISTRICT

PLATE 4C-17

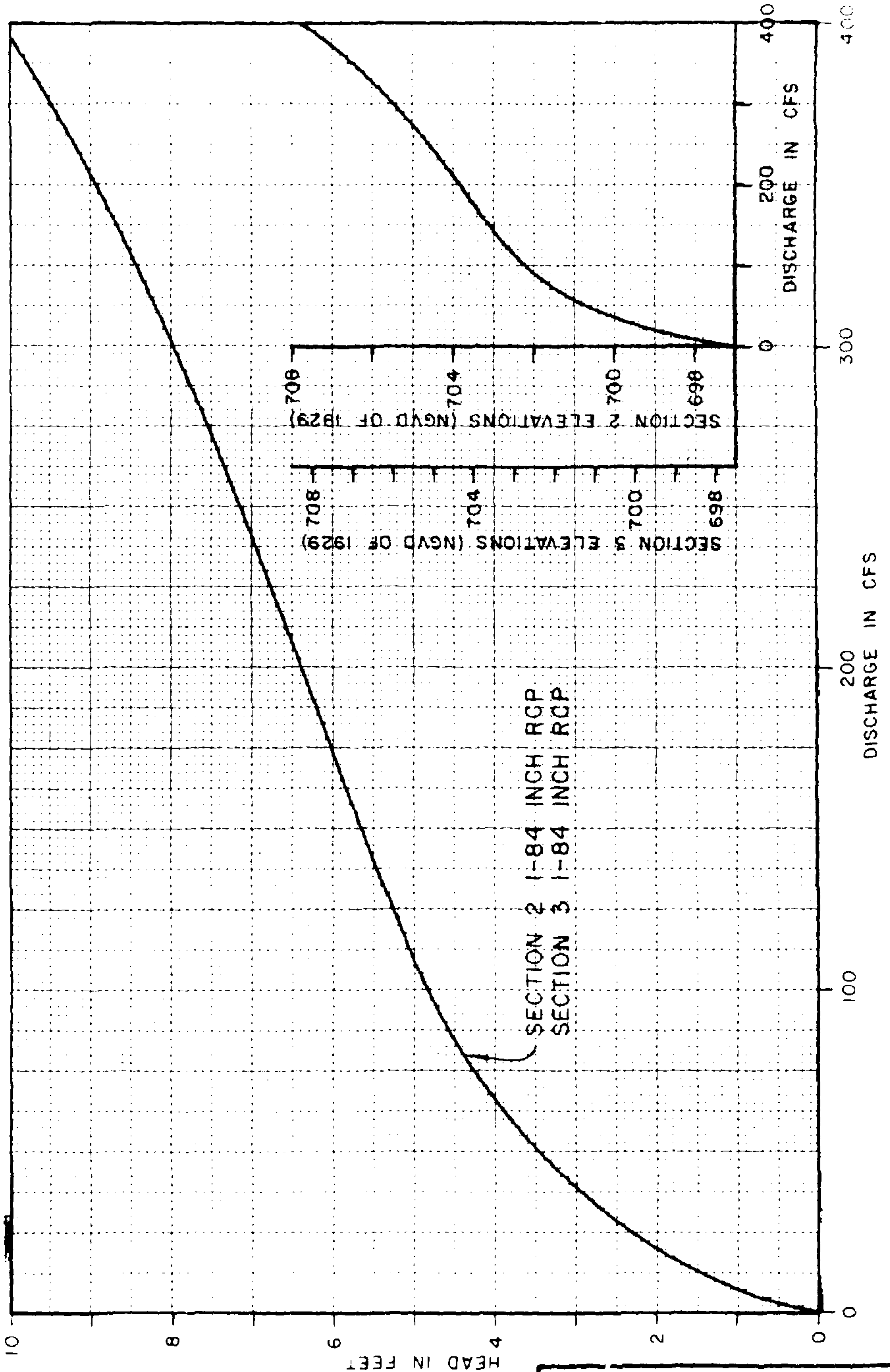




FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

DISCHARGE-RATING CURVES
SECTION I PROPOSED OUTLET

ST. PAUL DISTRICT

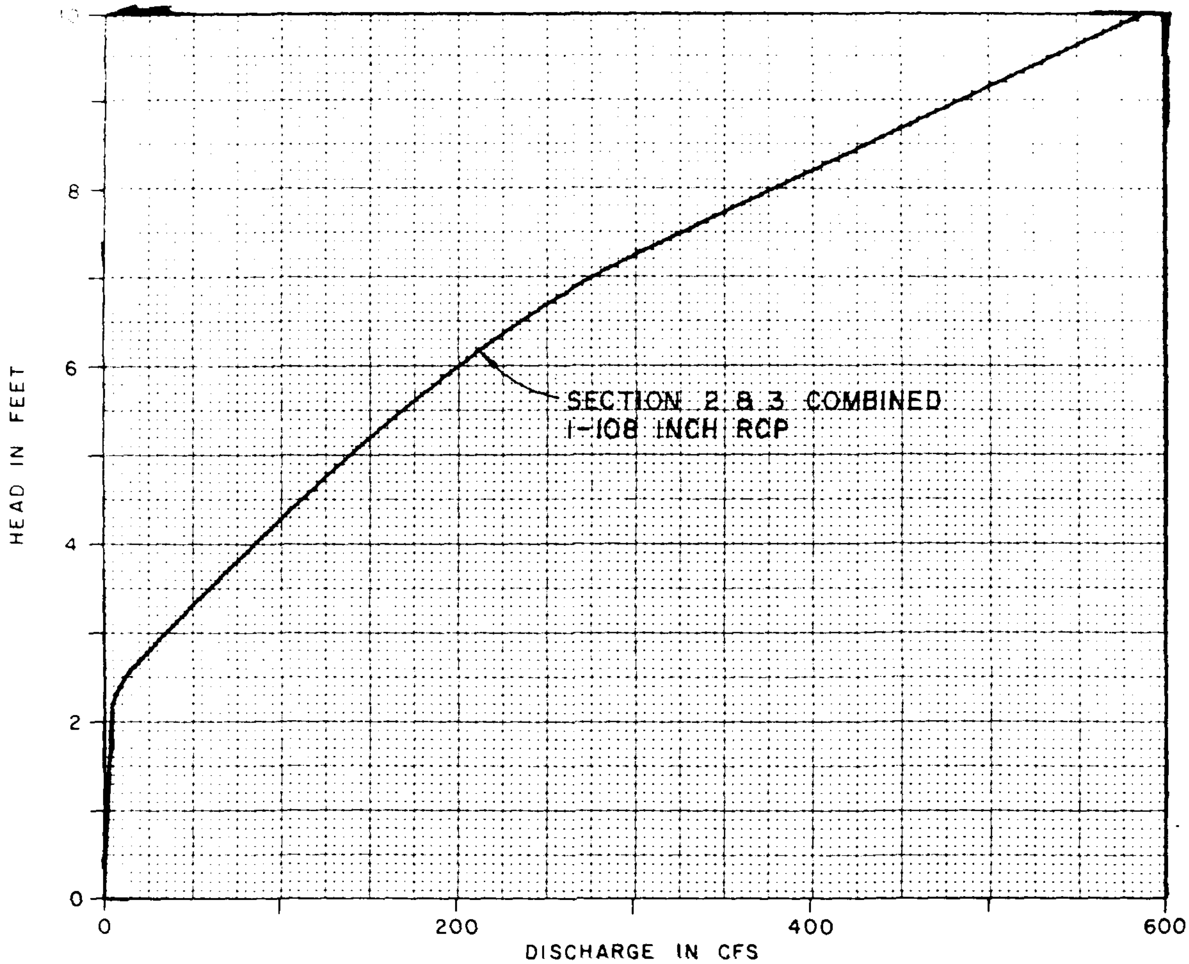


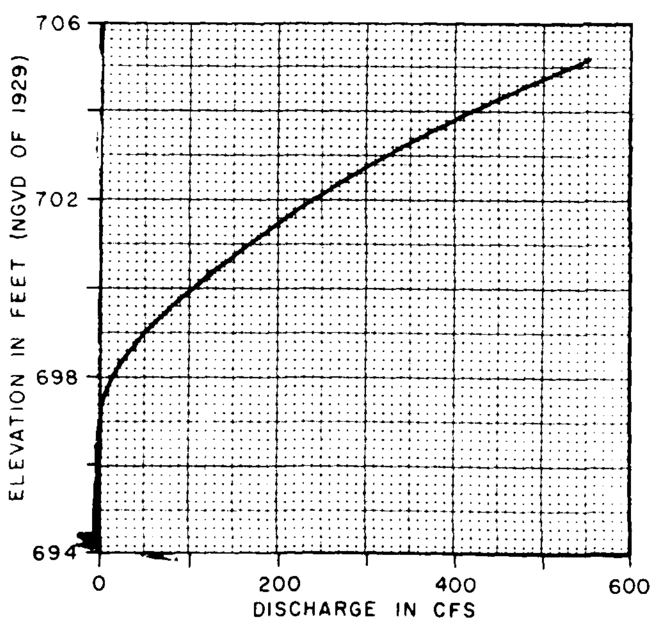
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

DISCHARGE-RATING CURVES
SECTIONS 2 & 3
PROPOSED OUTLETS

ST PAUL DISTRICT

PLATE 4C-19



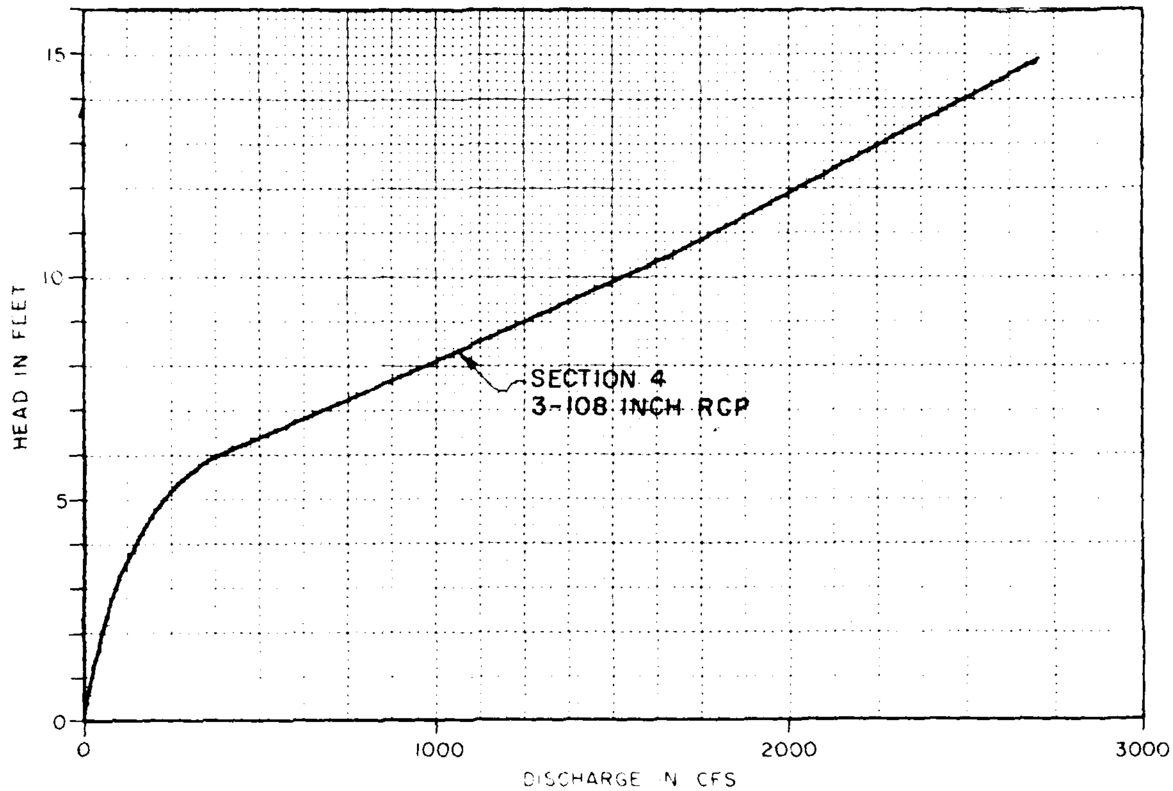


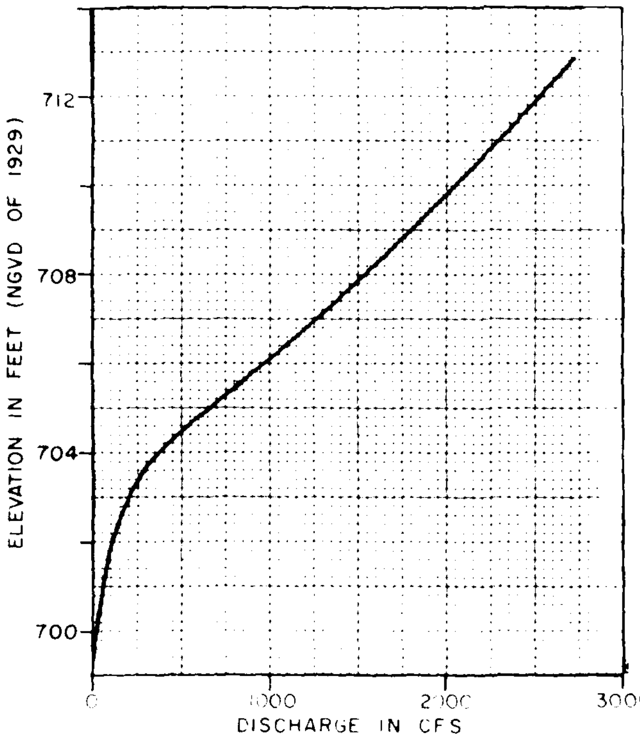
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

DISCHARGE-RATING CURVE
SECTION 2 & 3 COMBINED
SINGLE OUTLET ALTERNATIVE

ST PAUL DISTRICT

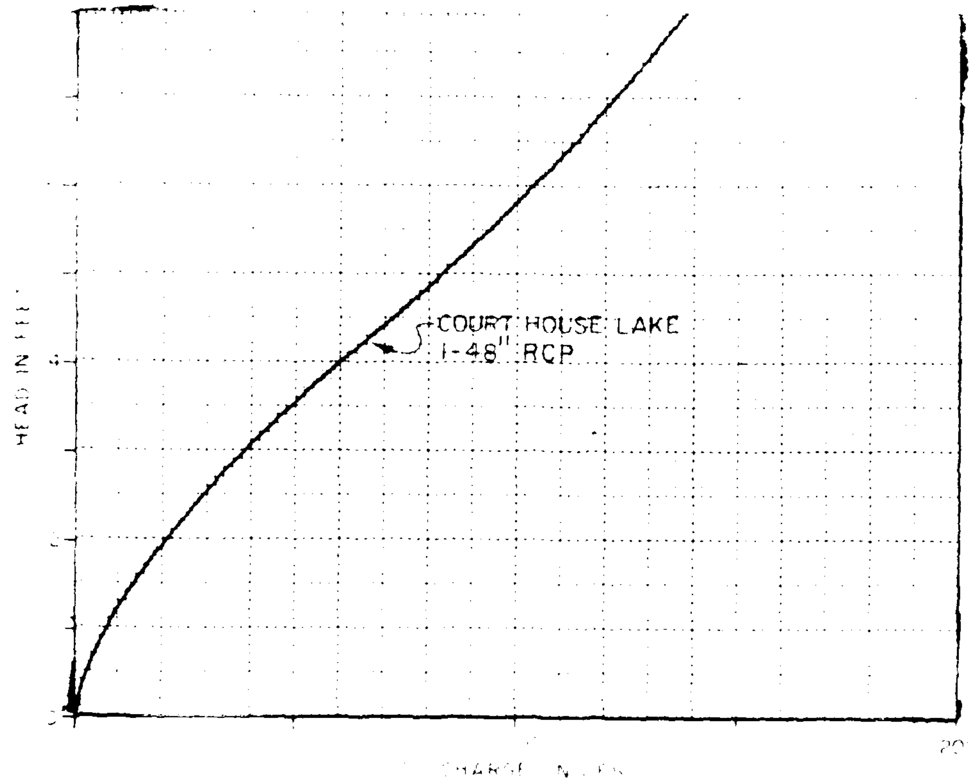
PLATE 4C-20

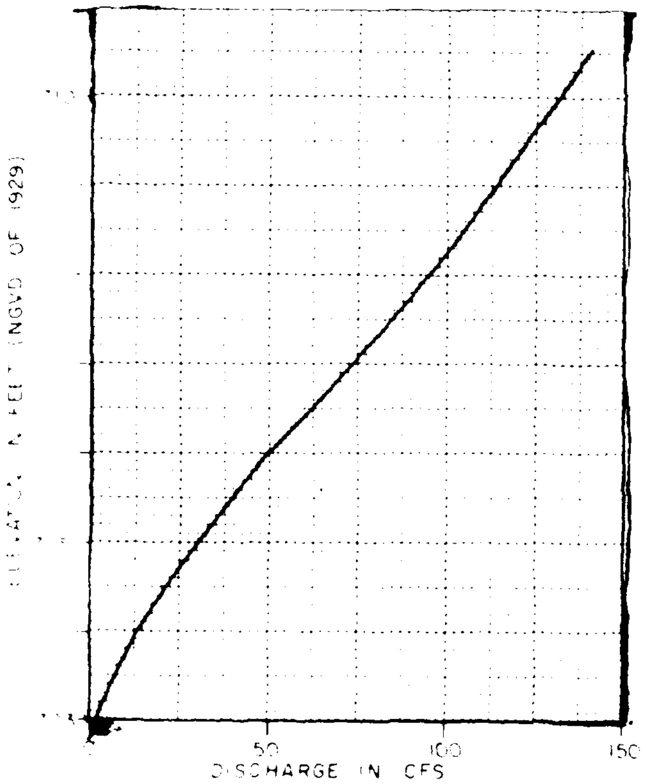




FLOOD CONTROL MINNESOTA RIVER
CHASKA MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
DISCHARGE-RATING CURVE
3-108 INCH OUTLETS
SECTION 4
PROPOSED OUTLETS
ST PAUL DISTRICT

PLATE 4C-21



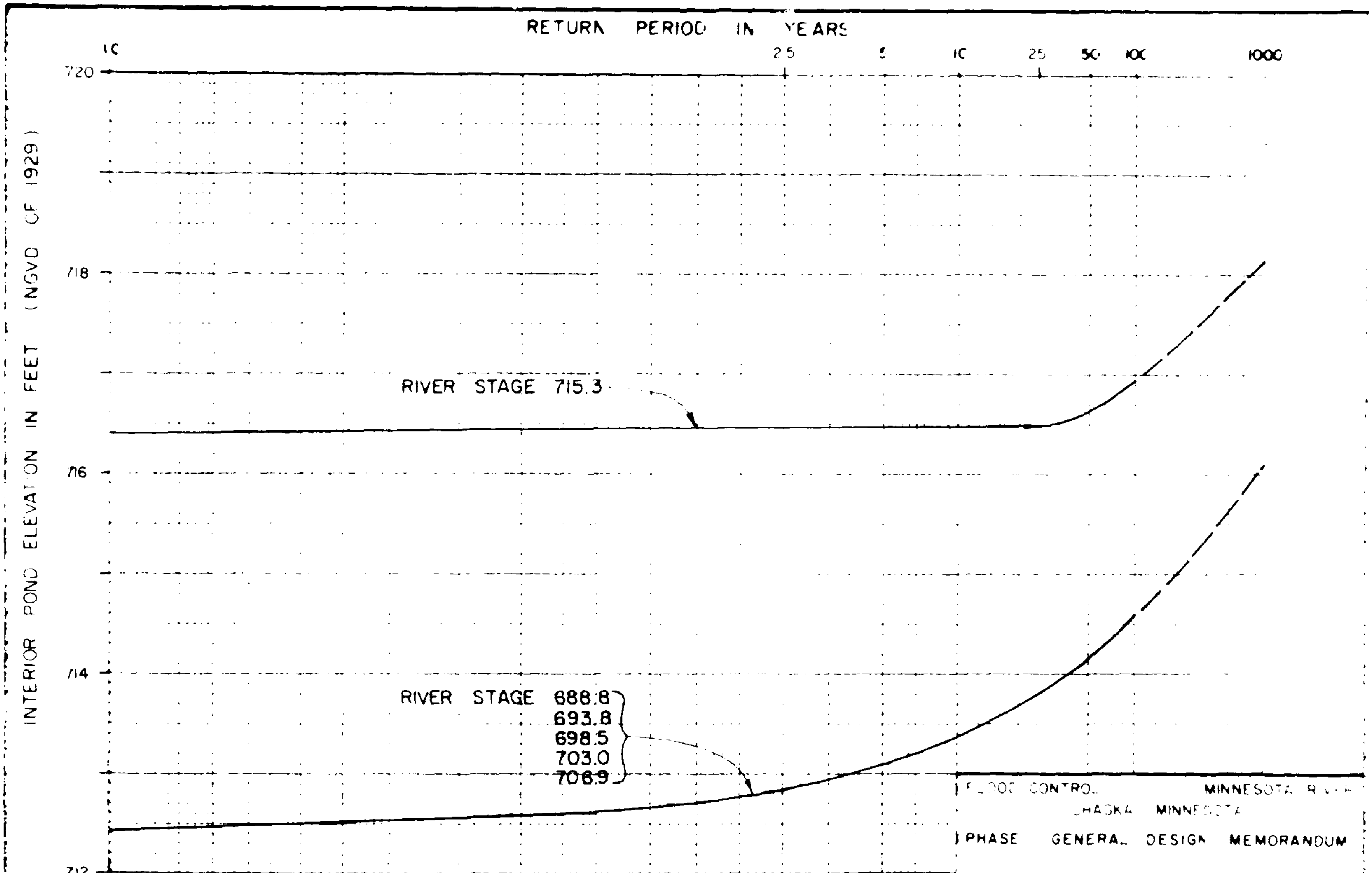


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

DISCHARGE-RATING CURVES
COURT HOUSE LAKE
PROPOSED OUTLET

ST PAUL DISTRICT

PLATE 4C-22



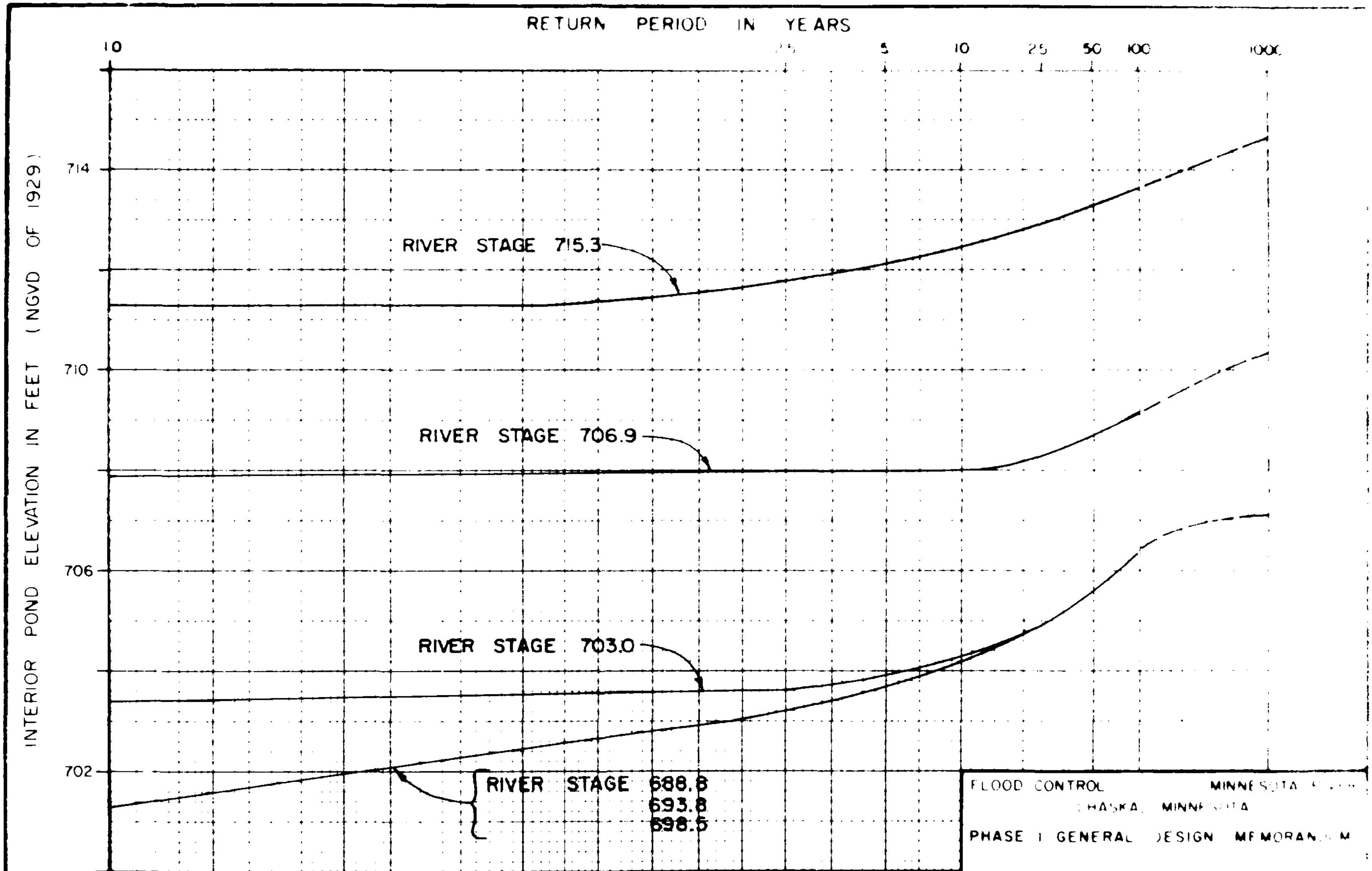
NOTE: NO PUMPING CONDITION
GATE REOPENS AT ONE FOOT HEAD

FLOOD CONTROL MINNESOTA RIVER
CHASKA MINNESOTA
PHASE GENERAL DESIGN MEMORANDUM

SECTION NO. 1
POND LEVEL FREQUENCY CURVES

ST. PAUL DISTRICT

PLATE 4C-23



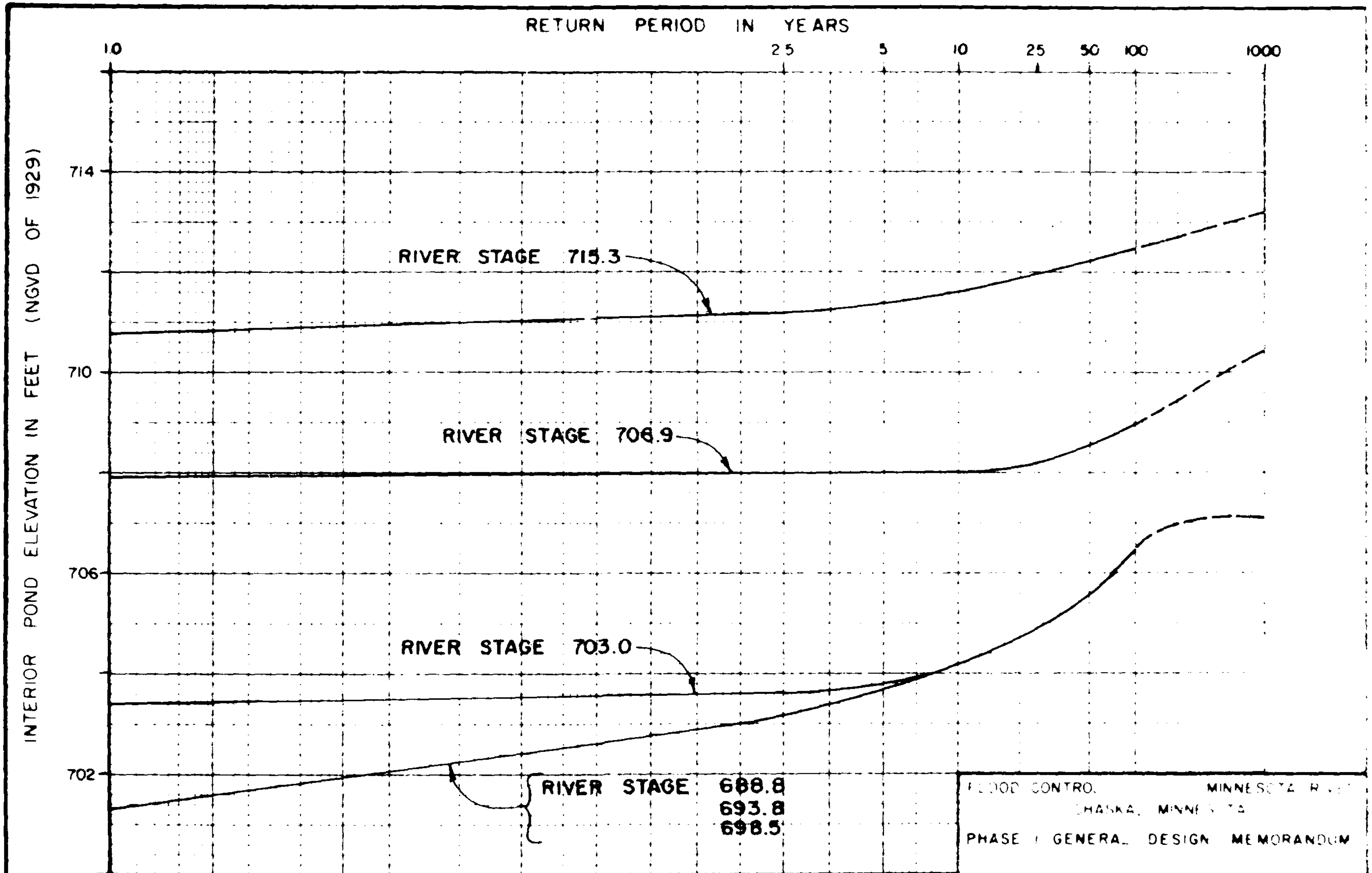
NOTE: NO PUMPING CONDITION
GATE REOPENS AT ONE FOOT HEAD

FLOOD CONTROL MINNESOTA R...
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

SECTION NO 2
POND LEVEL FREQUENCY CURVES

ST. PAUL DISTRICT

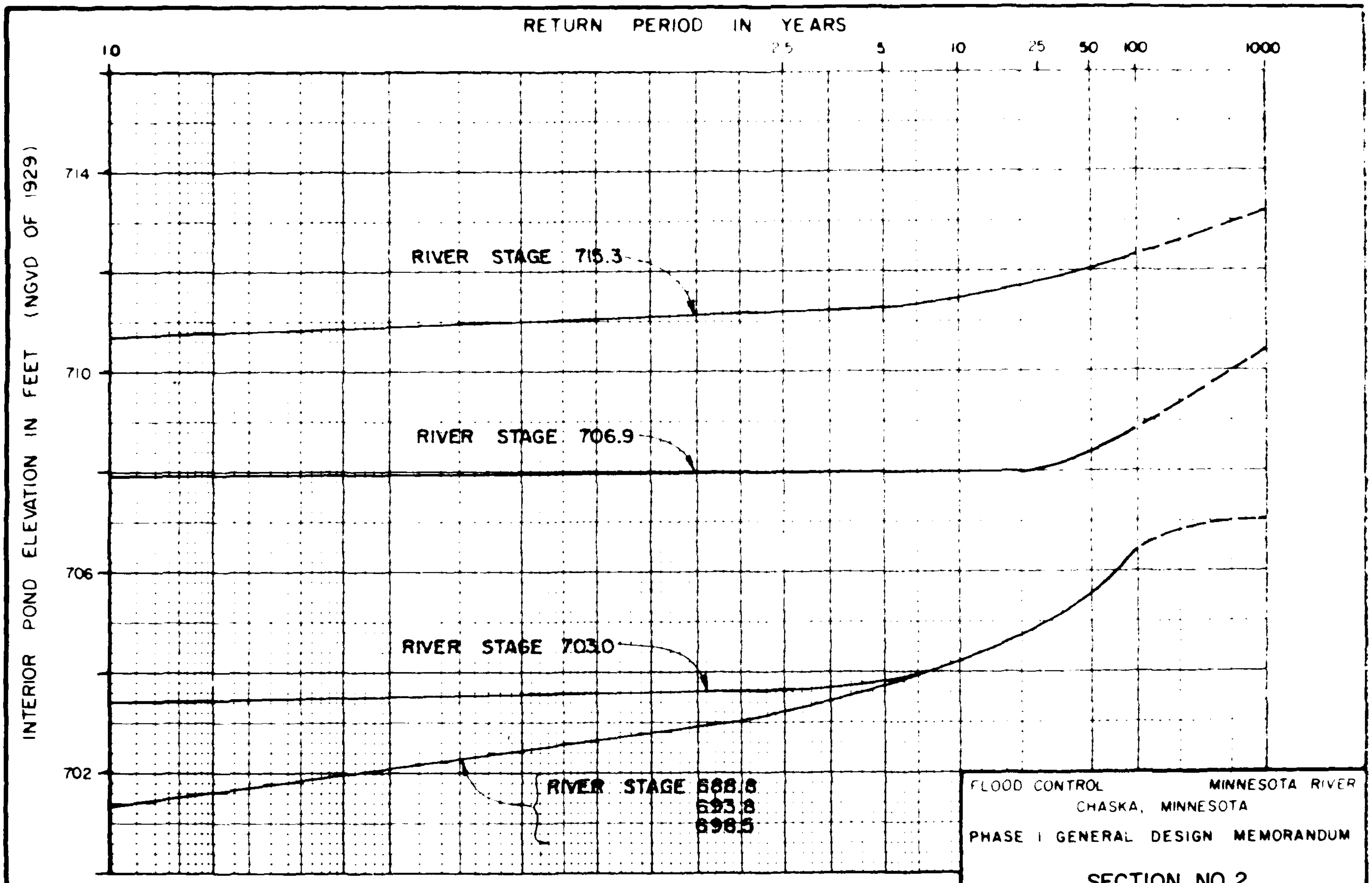
PLATE 4C-24



NOTE: 3,000 GPM PUMPING STATION
GATE REOPENS AT ONE FOOT HEAD

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

SECTION NO. 2
POND LEVEL FREQUENCY CURVES
ST. PAUL DISTRICT



NOTE: 5,000 GPM PUMPING STATION
GATE REOPENS AT ONE FOOT HEAD

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

SECTION NO. 2
POND LEVEL FREQUENCY CURVES

ST PAUL DISTRICT

PLATE 4C-26

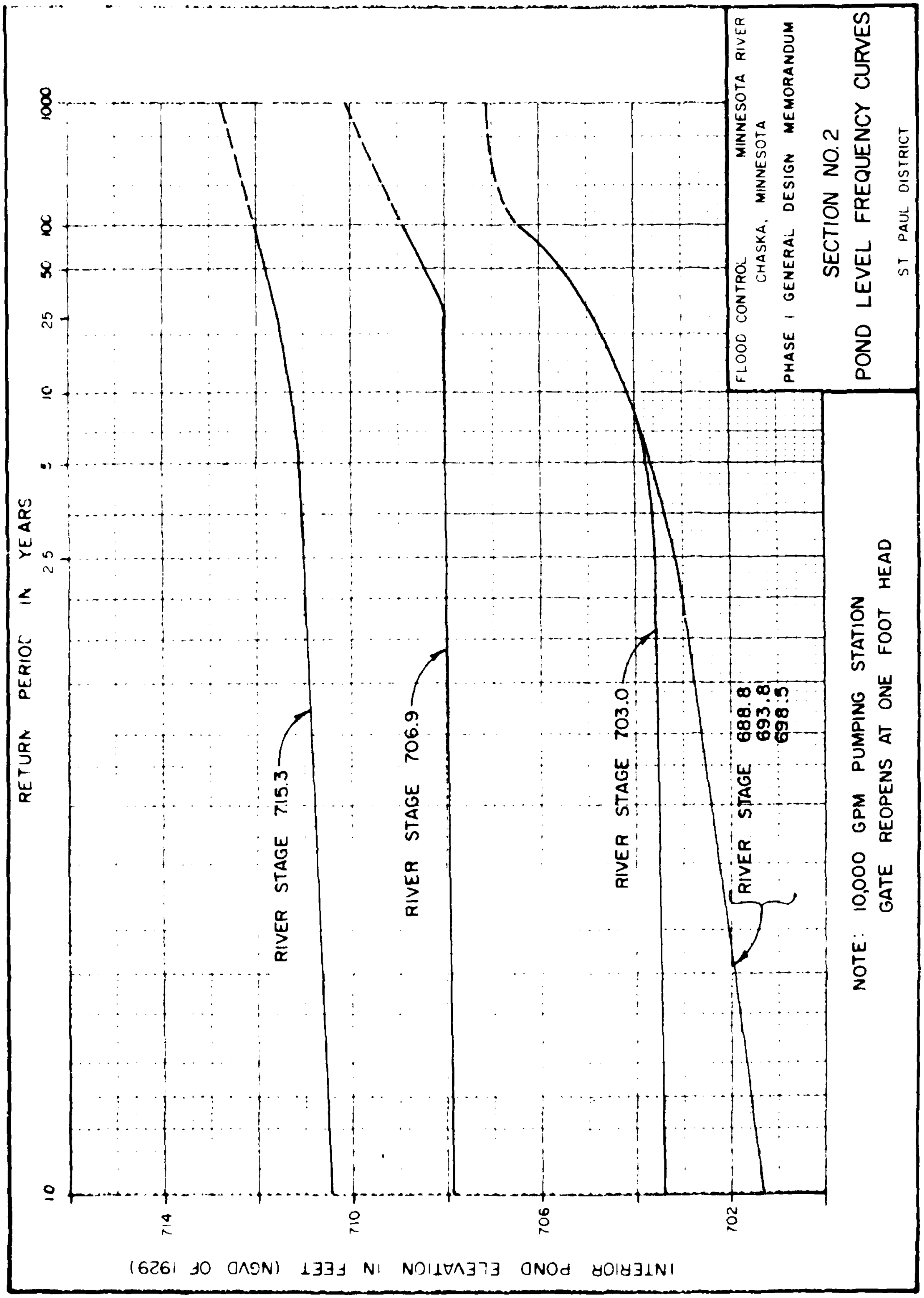

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
SECTION NO. 2
POND LEVEL FREQUENCY CURVES
ST PAUL DISTRICT
RETURN PERIOD IN YEARS
1000
100
50
25
10
5
2.5
1.0
RIVER STAGE 715.3
RIVER STAGE 706.9
RIVER STAGE 703.0
RIVER STAGE 688.8
693.8
698.5
714
710
706
702
INTERIOR POND ELEVATION IN FEET (NGVD OF 1929)
NOTE: 10,000 GPM PUMPING STATION
GATE REOPENS AT ONE FOOT HEAD

PLATE 4C-27

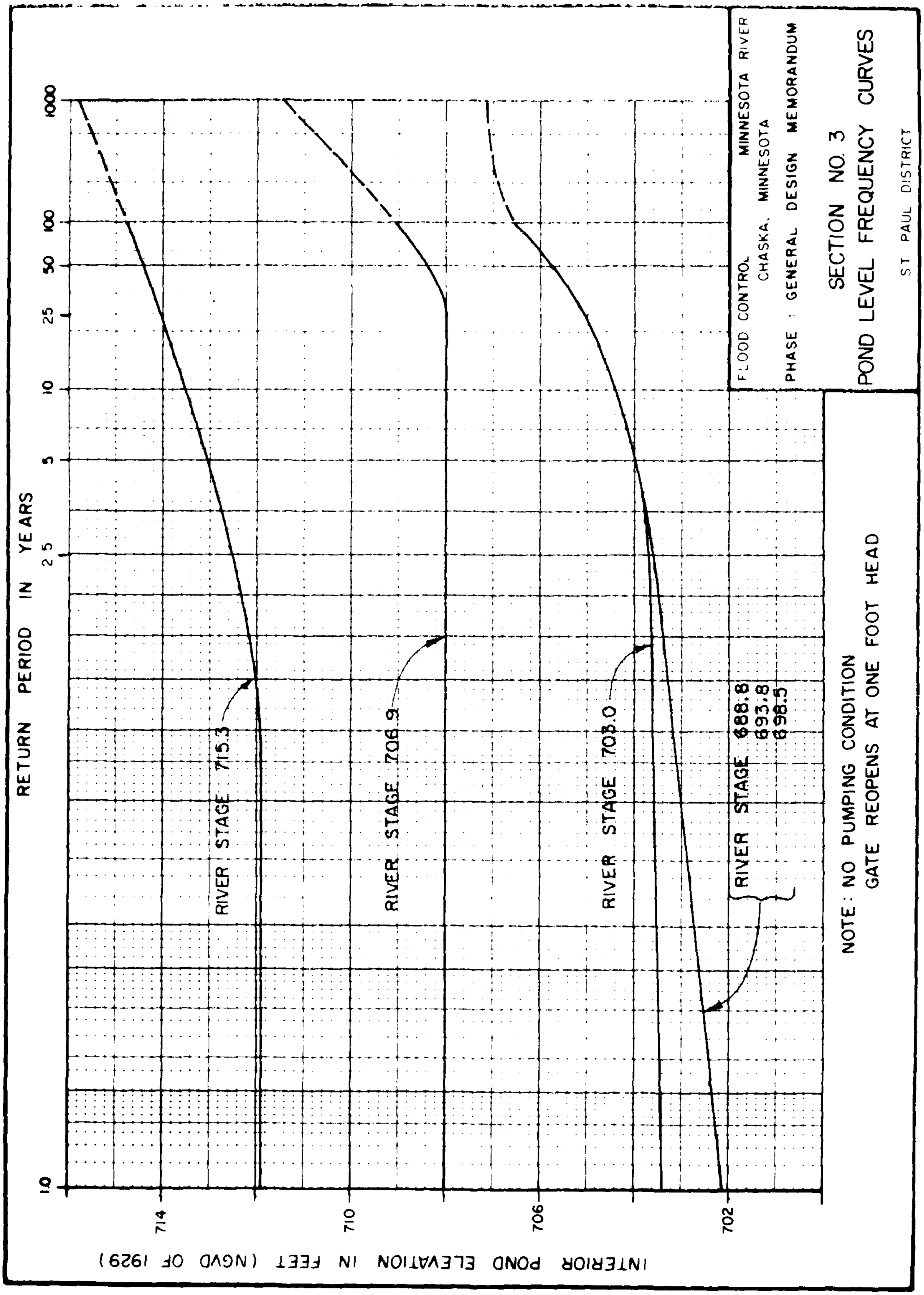

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE : GENERAL DESIGN MEMORANDUM
SECTION NO. 3
POND LEVEL FREQUENCY CURVES
ST PAUL DISTRICT
RETURN PERIOD IN YEARS
1.0
2.5
5
10
25
50
100
1000
INTERIOR POND ELEVATION IN FEET (NGVD OF 1929)
714
710
706
702
RIVER STAGE 715.3
RIVER STAGE 706.9
RIVER STAGE 703.0
RIVER STAGE 688.8
693.8
698.5
NOTE: NO PUMPING CONDITION
GATE REOPENS AT ONE FOOT HEAD

PLATE 4C-28

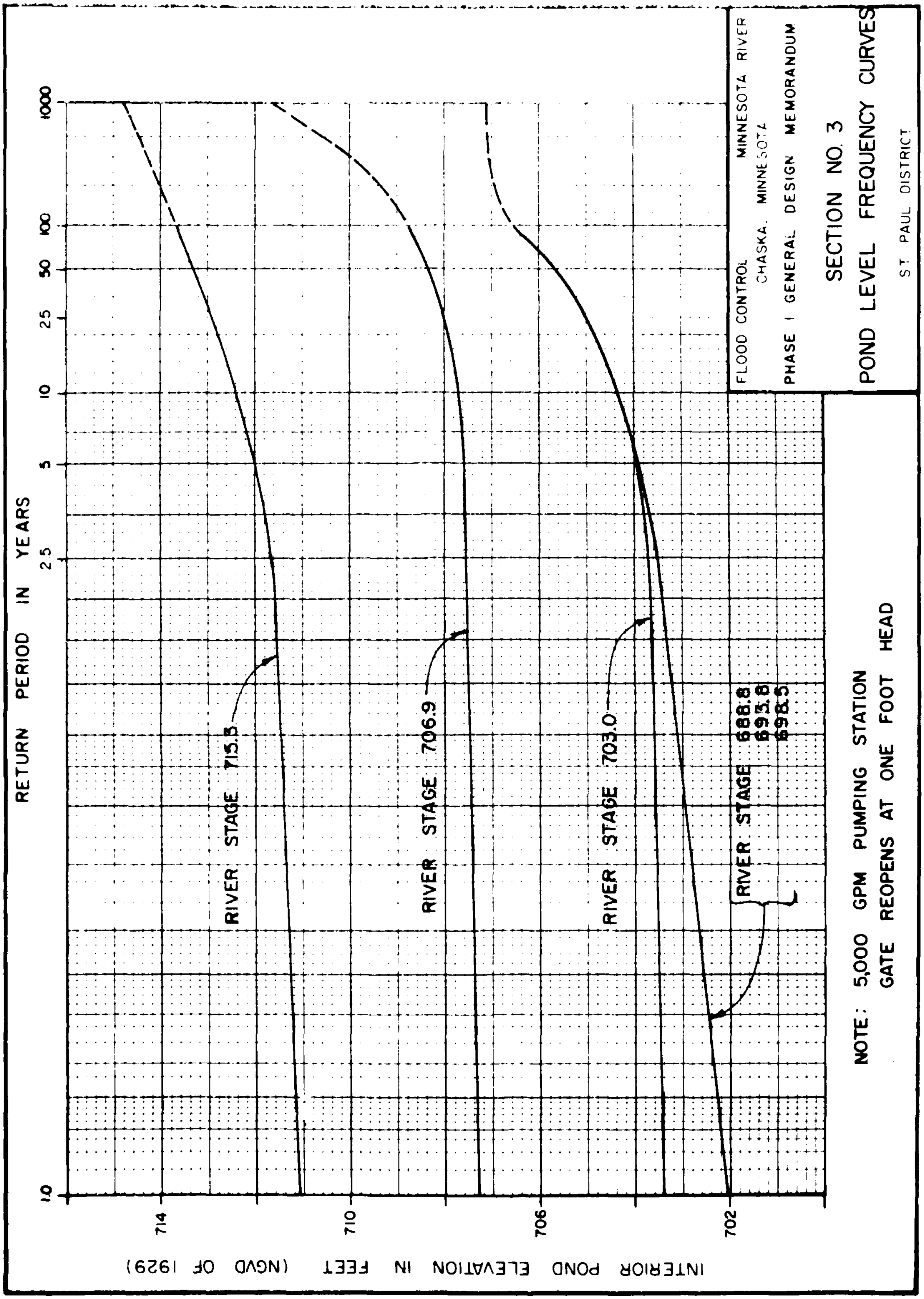

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
SECTION NO. 3
POND LEVEL FREQUENCY CURVES
ST. PAUL DISTRICT
RETURN PERIOD IN YEARS
1000
100
50
25
10
5
2.5
1.0
RIVER STAGE 715.3
RIVER STAGE 706.9
RIVER STAGE 703.0
RIVER STAGE 688.8
693.8
698.5
NOTE: 5,000 GPM PUMPING STATION
GATE REOPENS AT ONE FOOT HEAD
714
710
706
702
INTERIOR POND ELEVATION IN FEET (NGVD OF 1929)

PLATE 4C-29

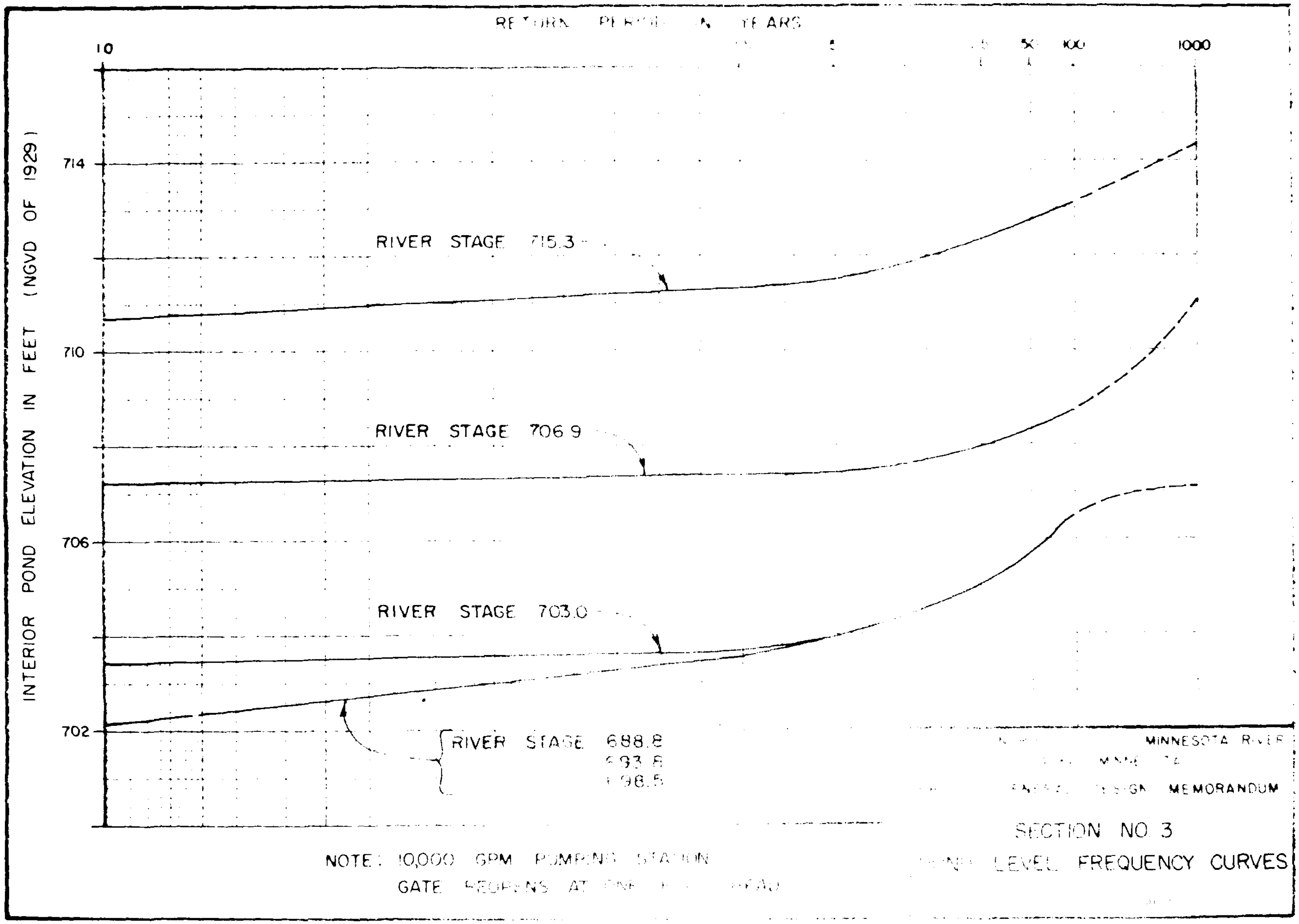
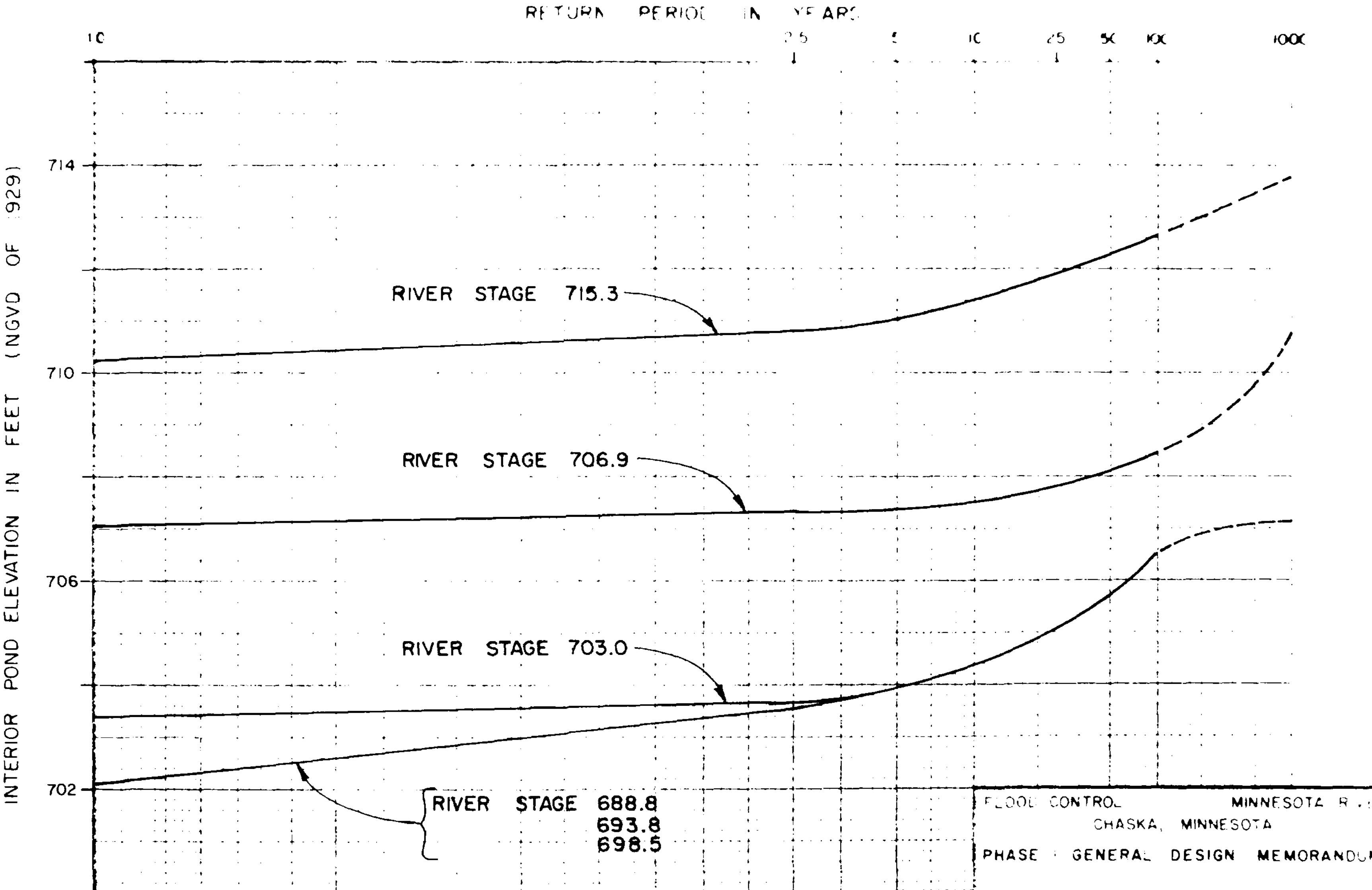

RETURN PERIOD IN YEARS
10
50
100
1000
INTERIOR POND ELEVATION IN FEET (NGVD OF 1929)
714
710
706
702
RIVER STAGE 715.3
RIVER STAGE 706.9
RIVER STAGE 703.0
RIVER STAGE 688.8
693.8
698.5
NOTE: 10,000 GPM PUMPING STATION
GATE REOPENS AT
MINNESOTA RIVER
DESIGN MEMORANDUM
SECTION NO. 3
LEVEL FREQUENCY CURVES

PLATE 4C-30

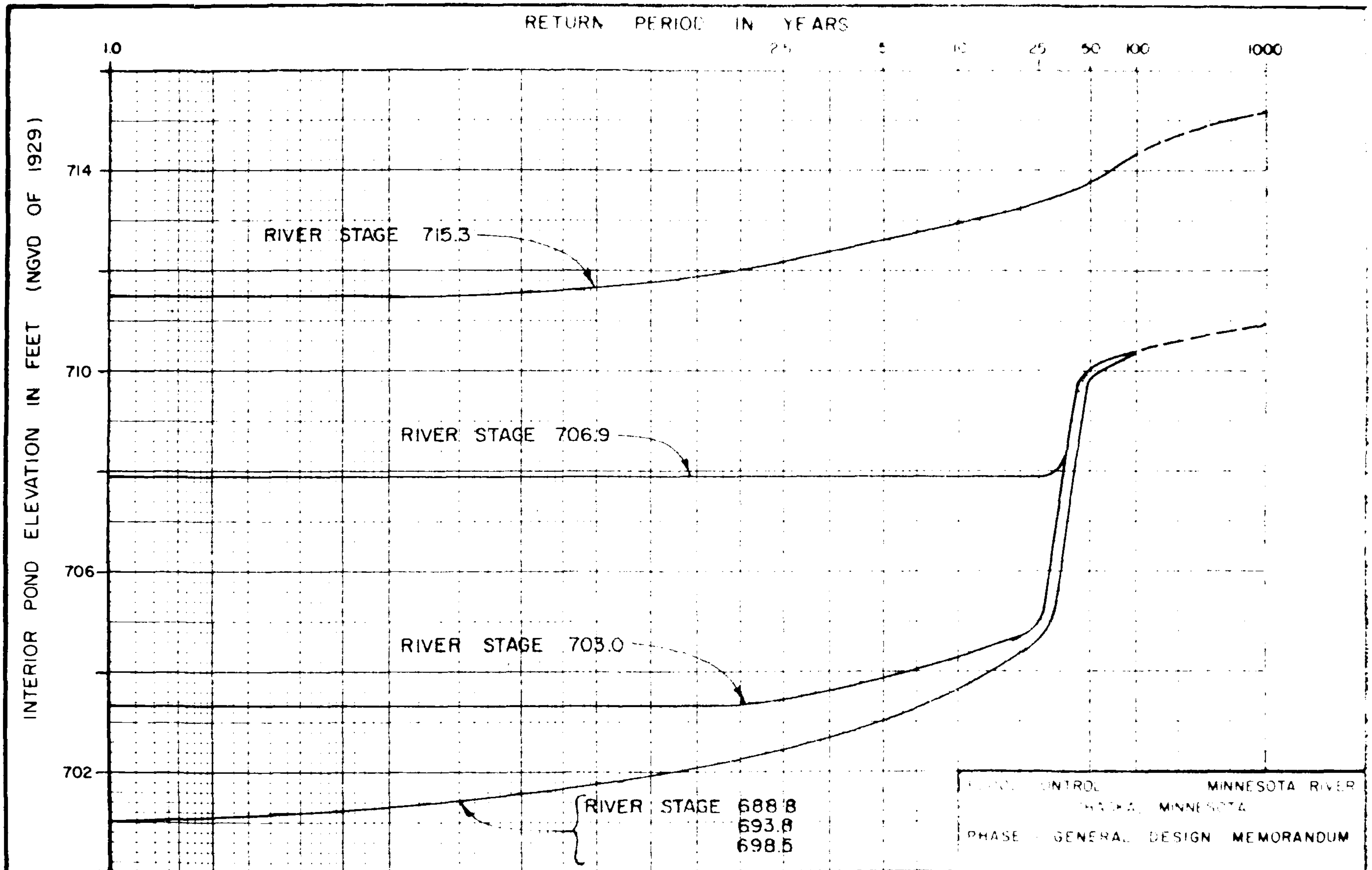


NOTE: 20,000 GPM PUMPING STATION
GATE REOPENS AT ONE FOOT HEAD

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

SECTION NO. 3
POND LEVEL FREQUENCY CURVES

ST. PAUL DISTRICT

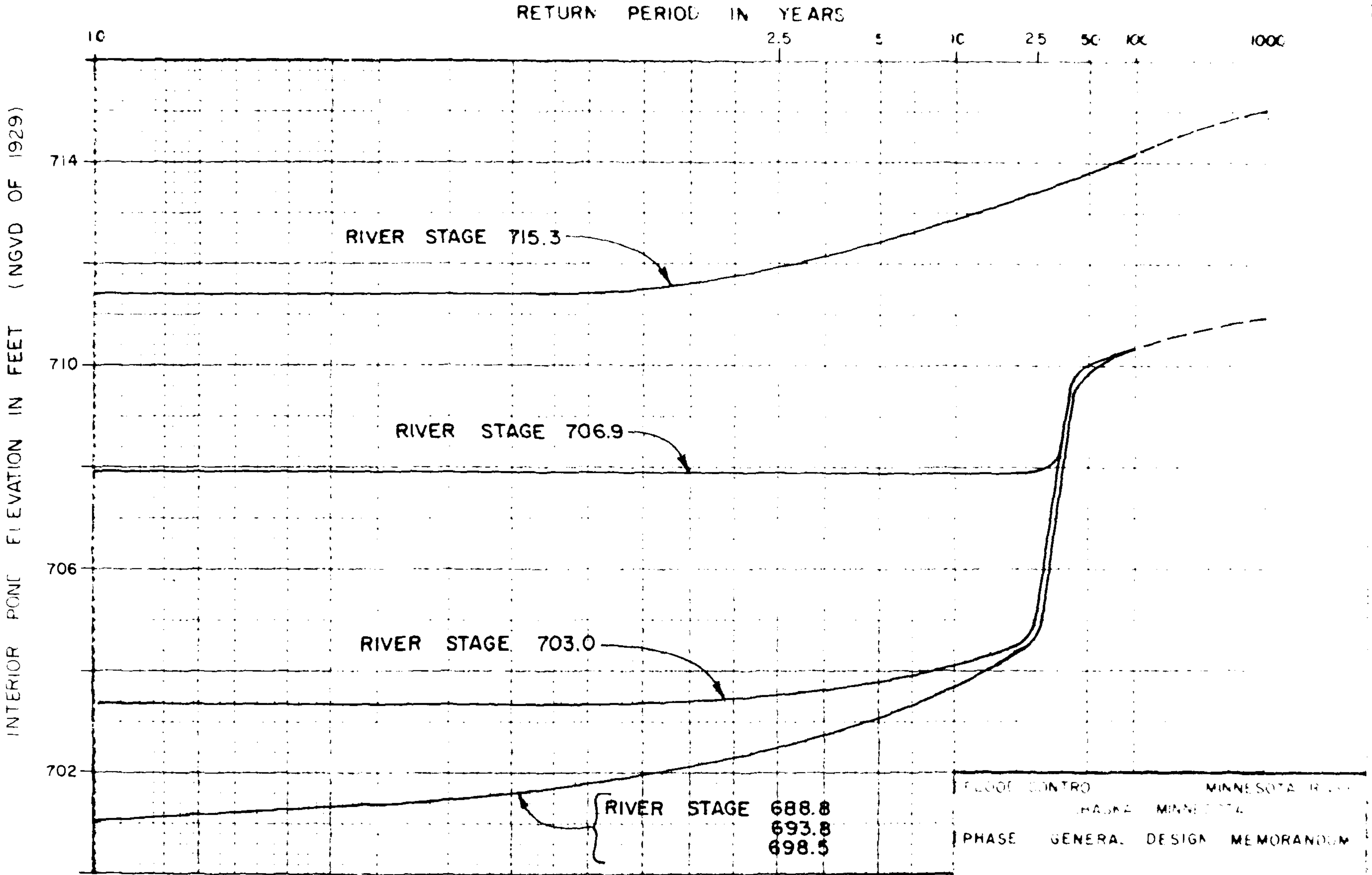


NOTE: NO PUMPING CONDITION
GATE REOPENS AT ONE FOOT HEAD

CONTROL MINNESOTA RIVER
MINNESOTA
PHASE GENERAL DESIGN MEMORANDUM

SECTIONS 2 & 3 COMBINED
POND LEVEL FREQUENCY CURVES

PLATE 4C-32



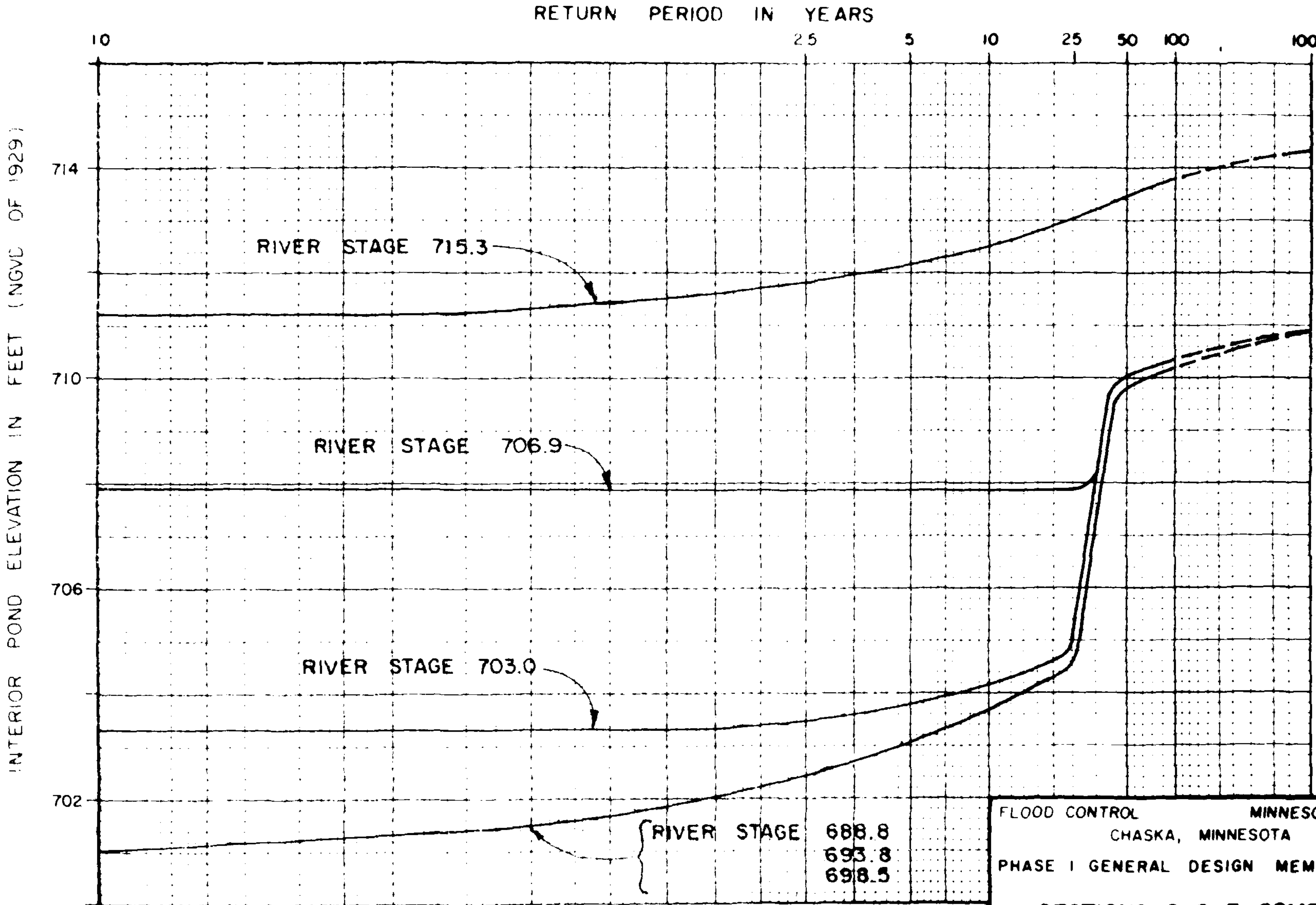
NOTE: 1,000 GPM PUMPING STATION
GATE REOPENS AT ONE FOOT HEAD

FLOOD CONTROL MINNESOTA RIVER
CHASKA MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

SECTIONS 2 & 3 COMBINED
POND LEVEL FREQUENCY CURVES

ST. PAUL DISTRICT

PLATE 4C-33

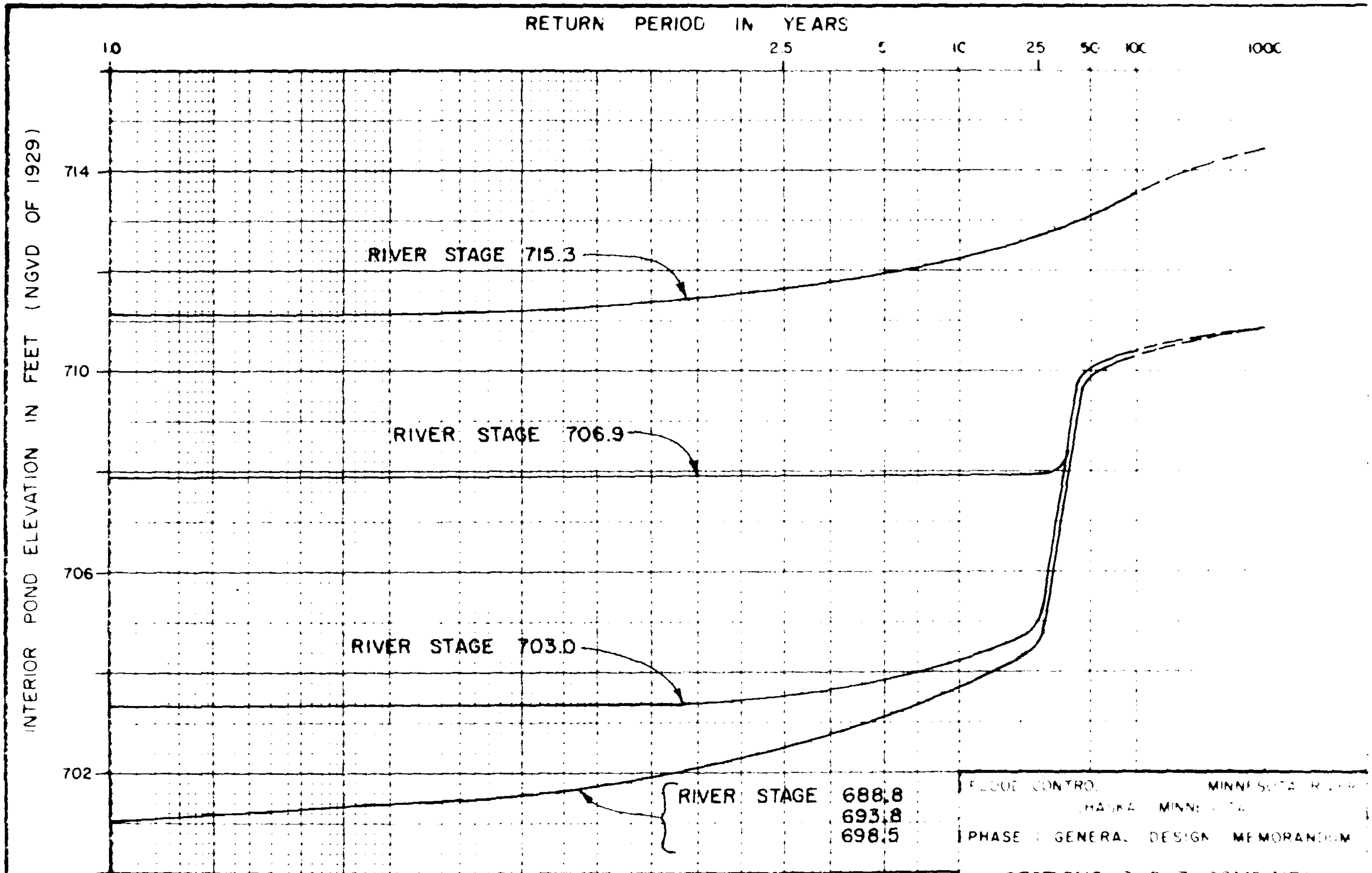


NOTE: 6,000 GPM PUMPING STATION
GATE REOPENS AT ONE FOOT HEAD

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

SECTIONS 2 & 3 COMBINED
POND LEVEL FREQUENCY CURVES

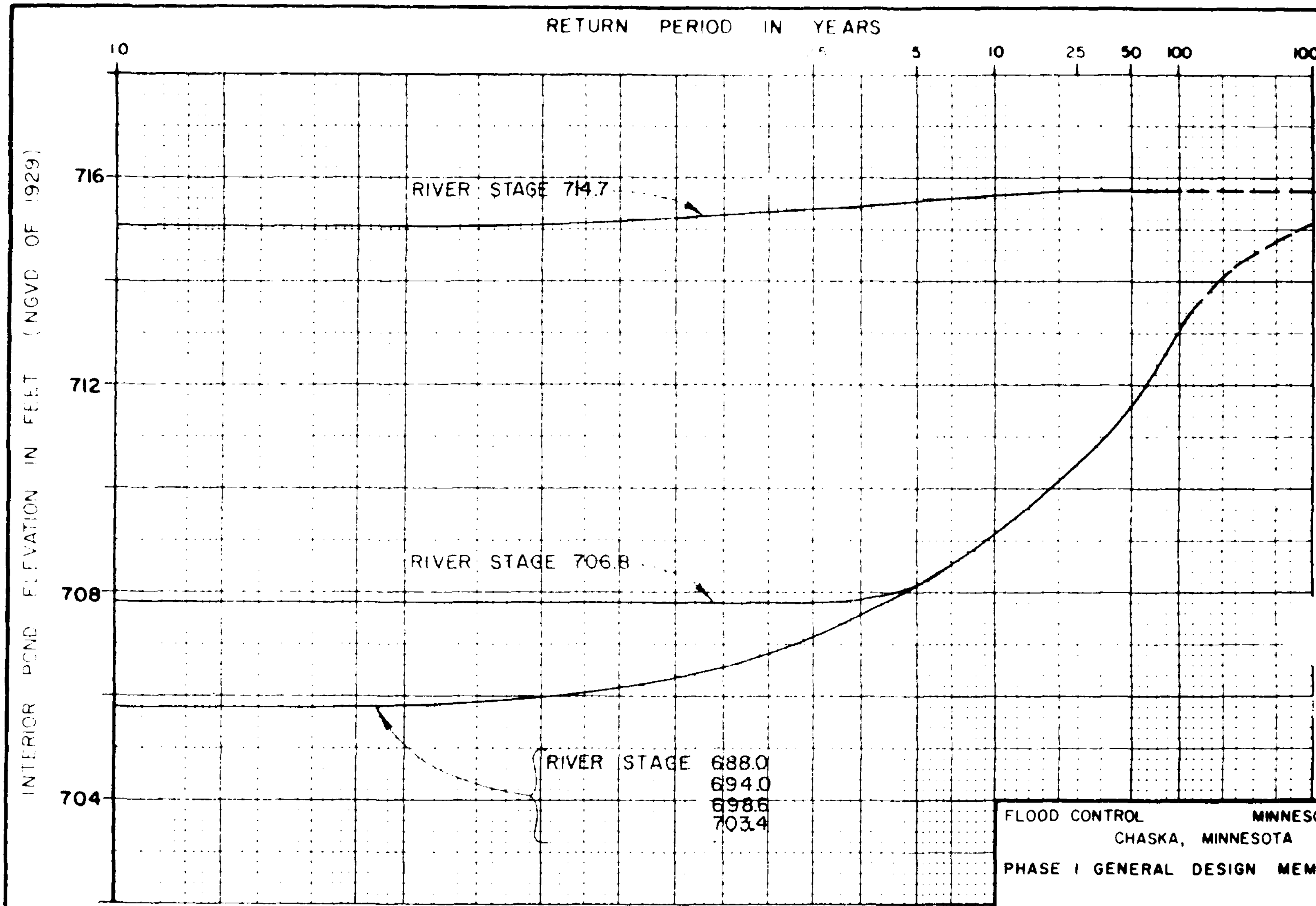
ST PAUL DISTRICT



NOTE: 12,000 GPM PUMPING STATION
GATE REOPENS AT ONE FOOT HEAD

FLOOD CONTROL MINNESOTA RIVER
CHASKA MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

SECTIONS 2 & 3 COMBINED
POND LEVEL FREQUENCY CURVES

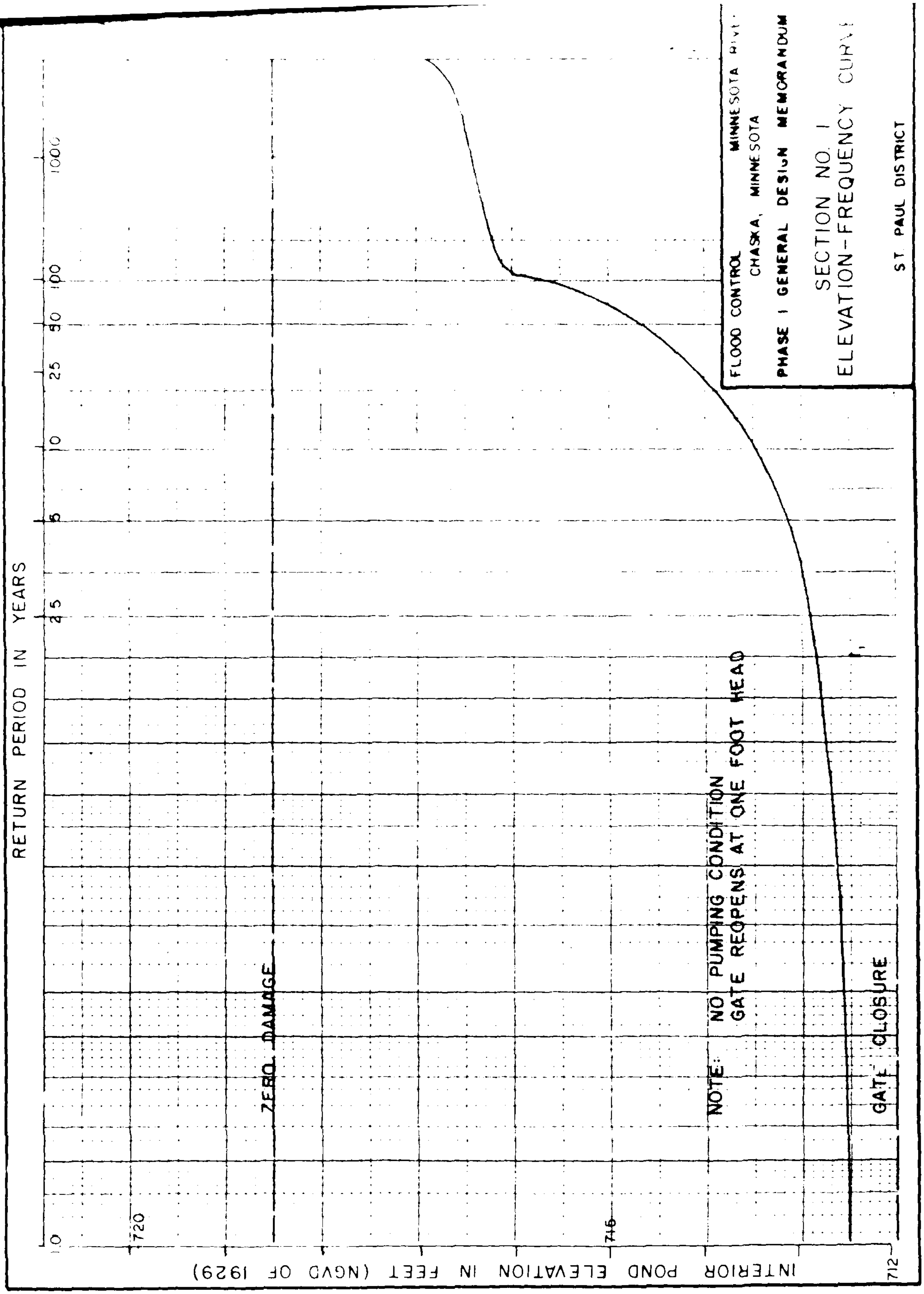


NOTE: NO PUMPING CONDITION
GATE REOPENS AT ONE FOOT HEAD

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

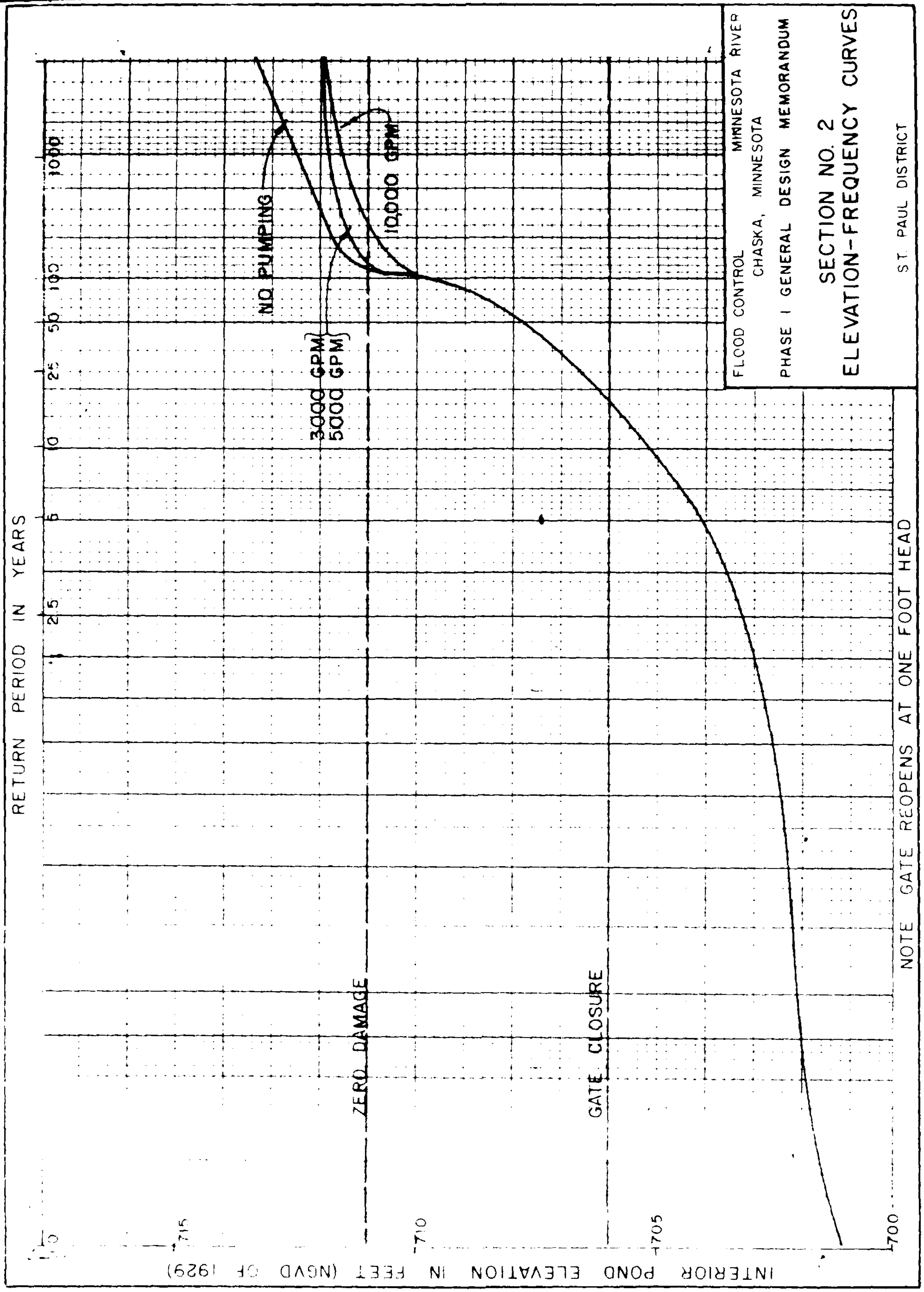
SECTION NO. 4
POND LEVEL FREQUENCY CURVES

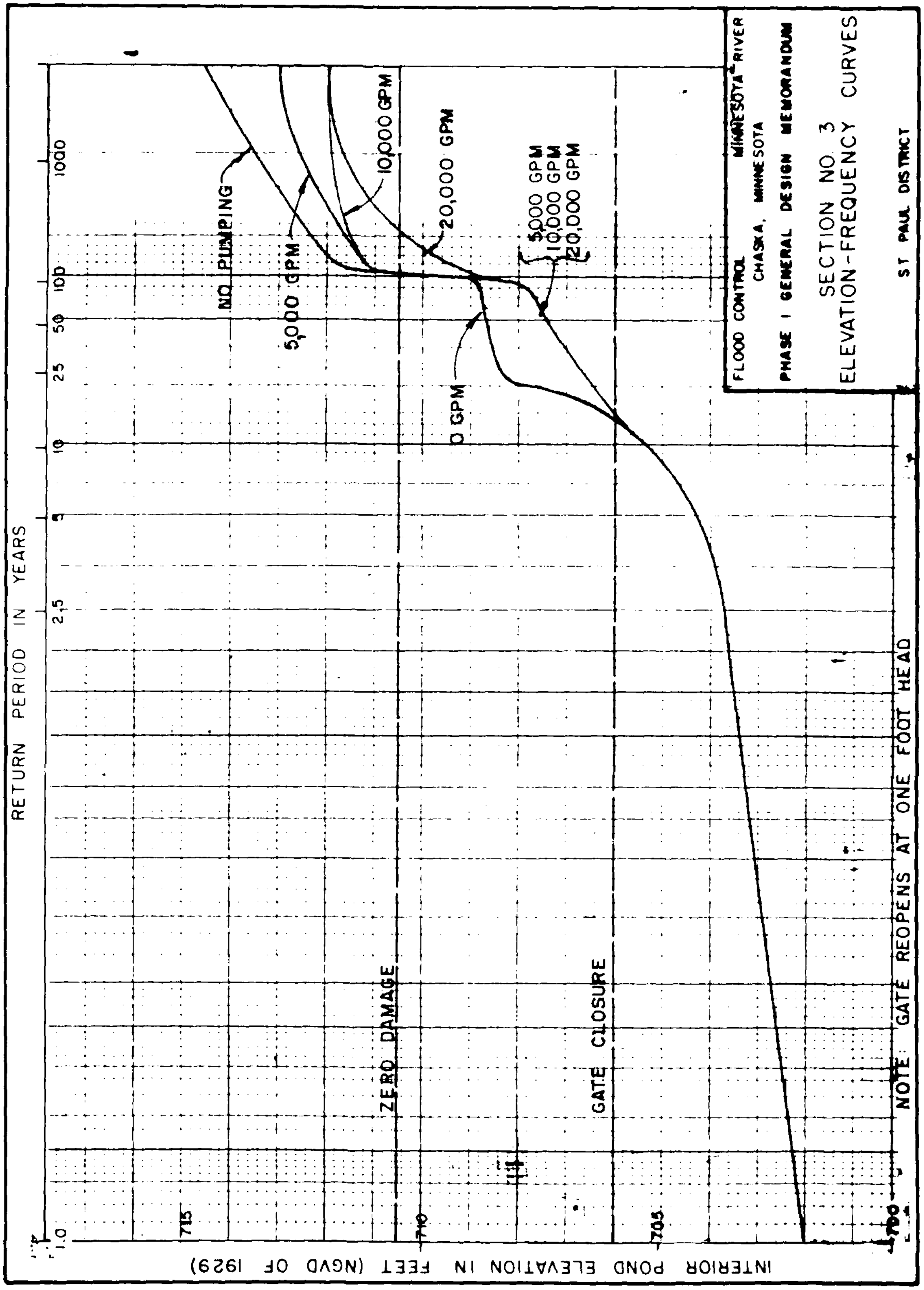
ST PAUL DISTRICT



FLOOD CONTROL MINNESOTA
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
SECTION NO. 1
ELEVATION-FREQUENCY CURVE
ST. PAUL DISTRICT
RETURN PERIOD IN YEARS
1.0
2.5
5
10
25
50
100
1000
ZERO DAMAGE
NOTE: NO PUMPING CONDITION
GATE REOPENS AT ONE FOOT HEAD
GATE CLOSURE
720
716
712
INTERIOR POND ELEVATION IN FEET (NGVD OF 1929)

PLATE 4C-37


FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
SECTION NO. 2
ELEVATION-FREQUENCY CURVES
ST. PAUL DISTRICT
RETURN PERIOD IN YEARS
INTERIOR POND ELEVATION IN FEET (NGVD OF 1929)
NO PUMPING
3000 GPM
5000 GPM
10,000 GPM
ZERO DAMAGE
GATE CLOSURE
NOTE GATE REOPENS AT ONE FOOT HEAD
1000
100
50
25
10
5
2.5
1
715
710
705
700



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
SECTION NO. 3
ELEVATION-FREQUENCY CURVES
ST PAUL DISTRICT
RETURN PERIOD IN YEARS
INTERIOR POND ELEVATION IN FEET (NGVD OF 1929)
1.0
2.5
5
10
25
50
100
1000
700
705
710
715
NO PUMPING
5,000 GPM
10,000 GPM
20,000 GPM
0 GPM
5,000 GPM
10,000 GPM
20,000 GPM
ZERO DAMAGE
GATE CLOSURE
NOTE: GATE REOPENS AT ONE FOOT HEAD

PLATE 4C-39

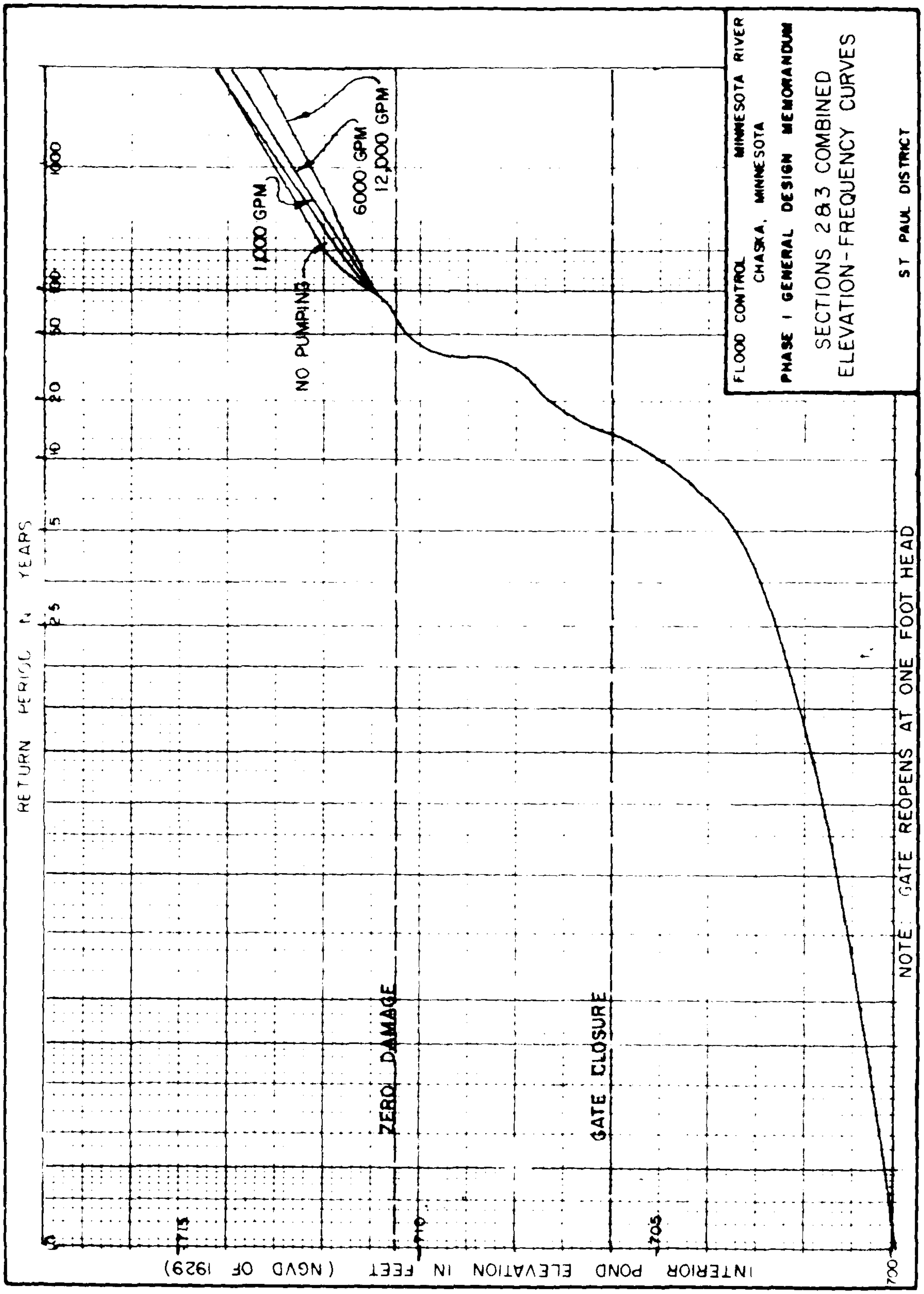
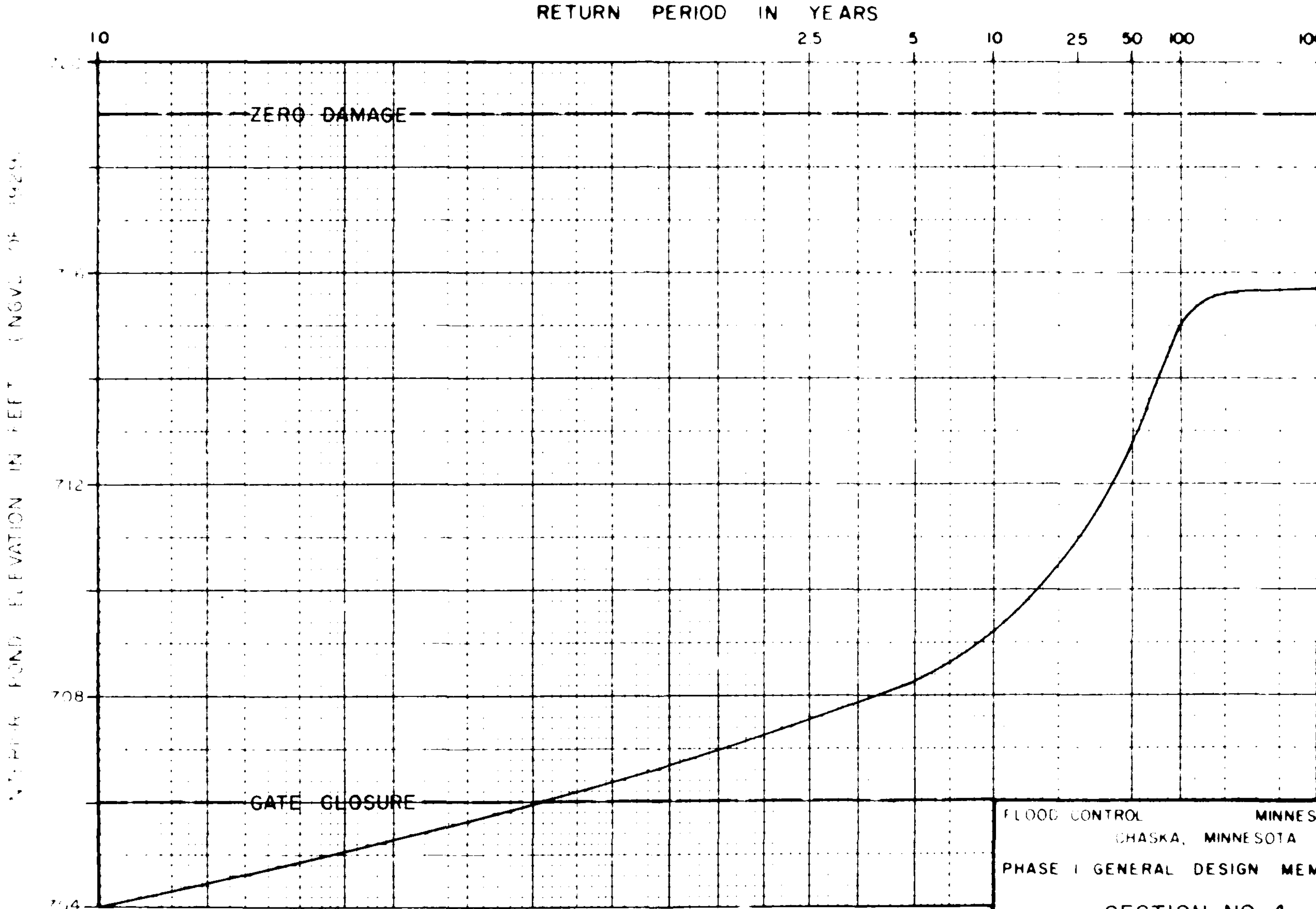

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
SECTIONS 2&3 COMBINED
ELEVATION-FREQUENCY CURVES
ST PAUL DISTRICT
RETURN PERIOD IN YEARS
INTERIOR POND ELEVATION IN FEET (NGVD OF 1929)
NOTE: GATE REOPENS AT ONE FOOT HEAD
ZERO DAMAGE
GATE CLOSURE
NO PUMPING
1,000 GPM
6000 GPM
12,000 GPM
1000
100
50
20
10
5
2.5
700
705
710
715

PLATE 4C-40



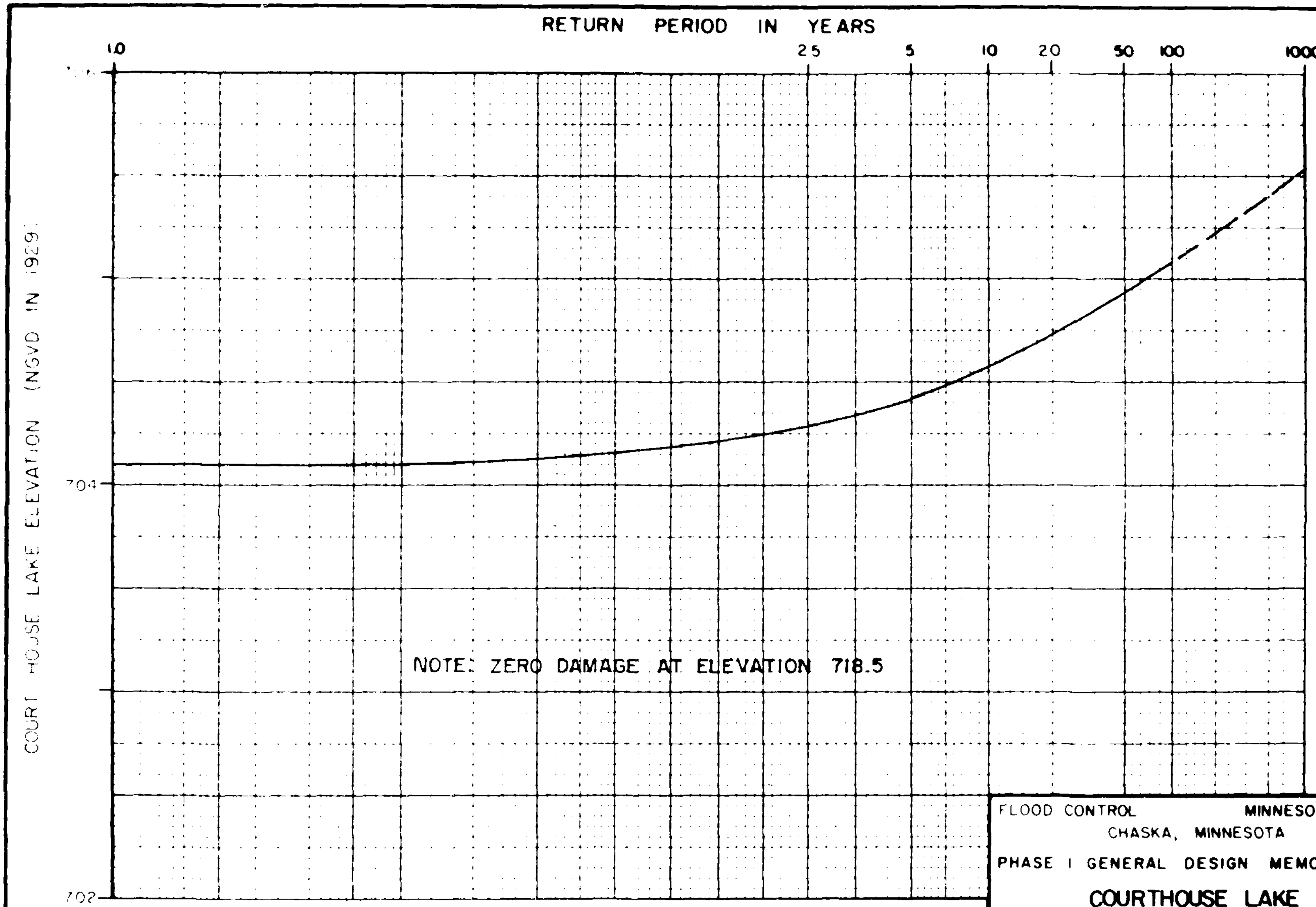
NOTE: NO PUMPING CONDITION
GATE REOPENS AT ONE FOOT HEAD

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

SECTION NO. 4
ELEVATION - FREQUENCY CURVE

ST. PAUL DISTRICT

PLATE 4C-41



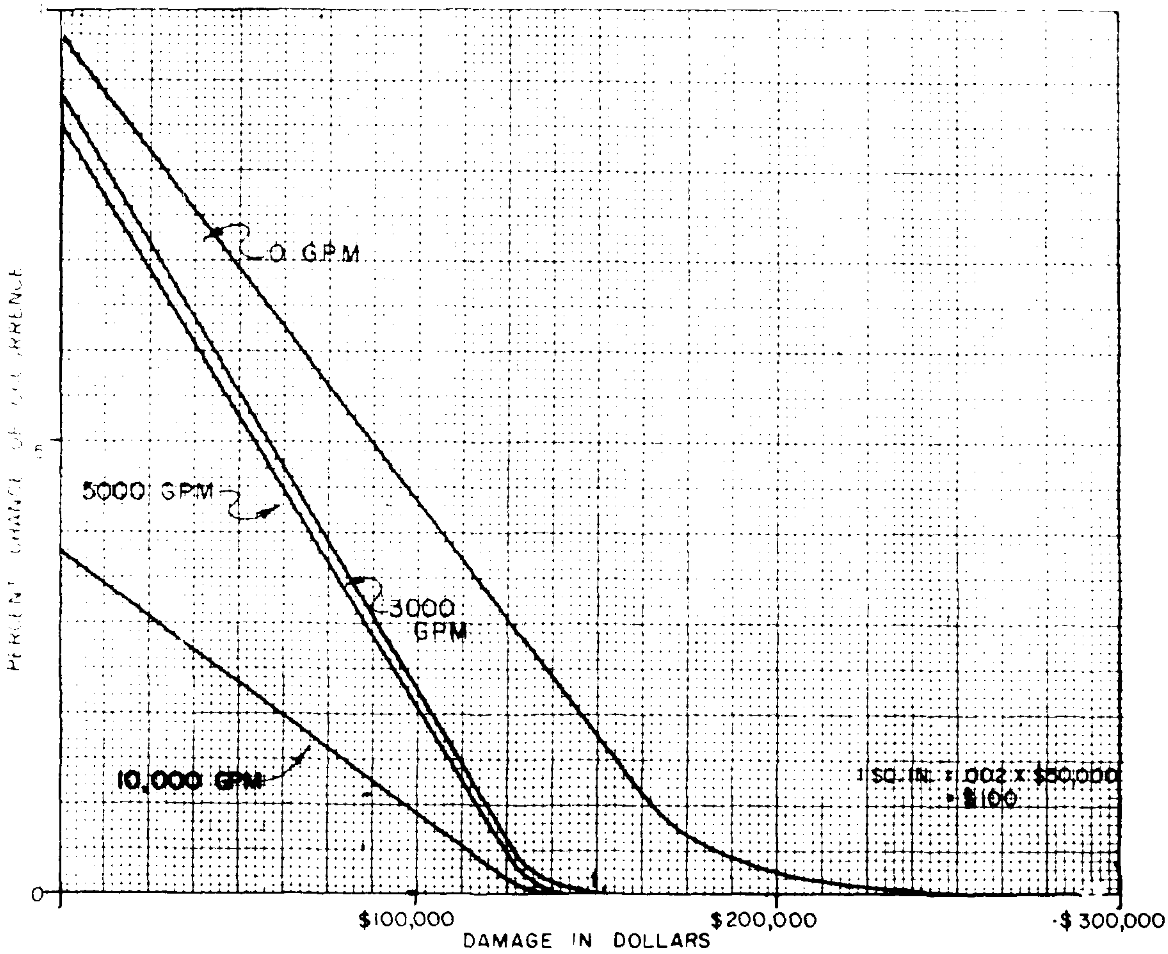
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

COURTHOUSE LAKE
ELEVATION FREQUENCY CURVE

ST PAUL DISTRICT

PLATE 4C-42

PUMP RATE GPM	AREA SQ IN	EST AVG ANN DAMAGES	EST AVG ANN BENEFITS
0	8.9	$ 890	$
3,000	[illegible]	[illegible]	[illegible]
5,000	5.5	550	340
10,000	2.5	[illegible]	640



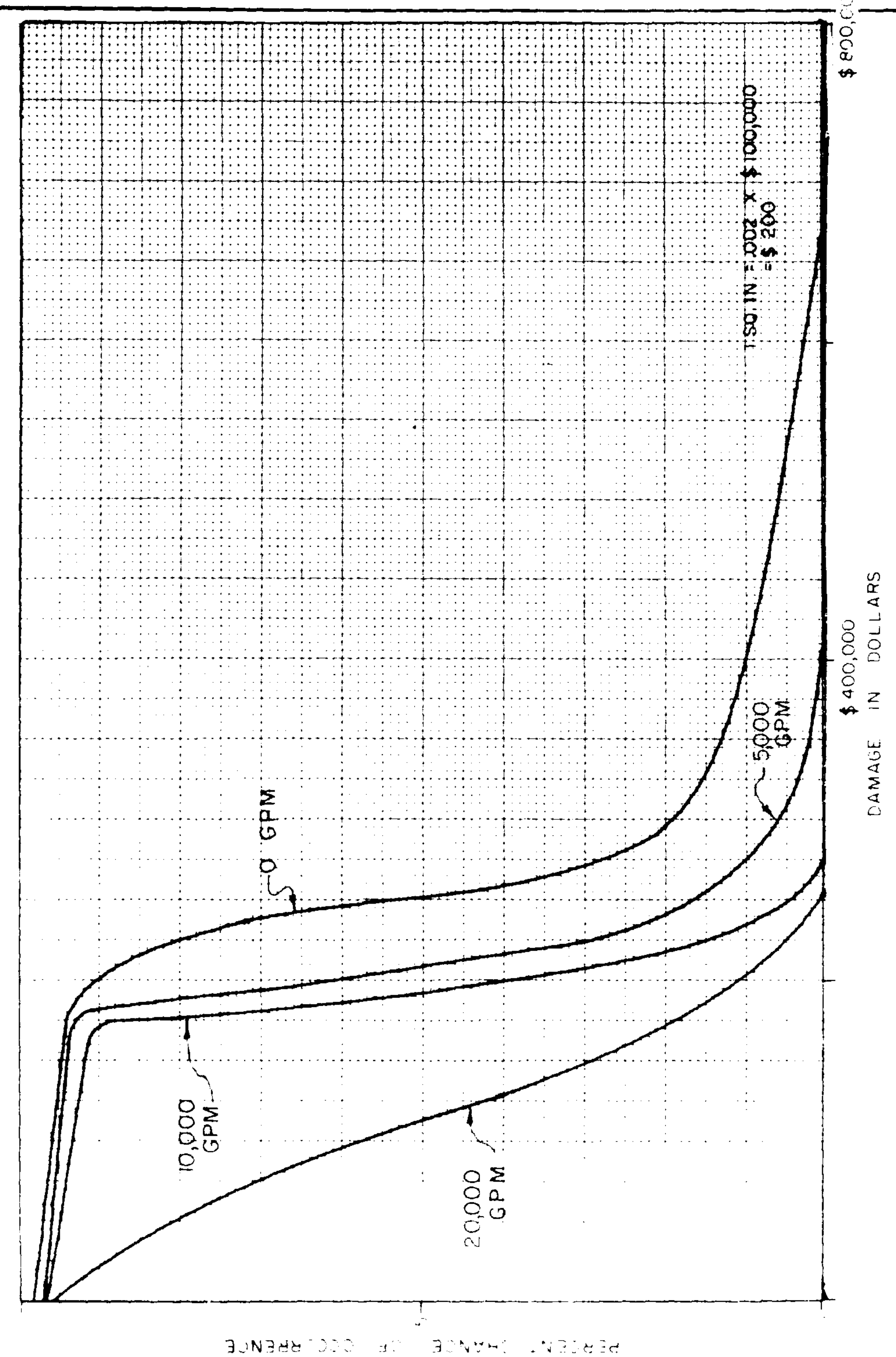
FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

SECTION 2
DAMAGE – FREQUENCY CURVES

ST PAUL DISTRICT

PLATE 4C-43

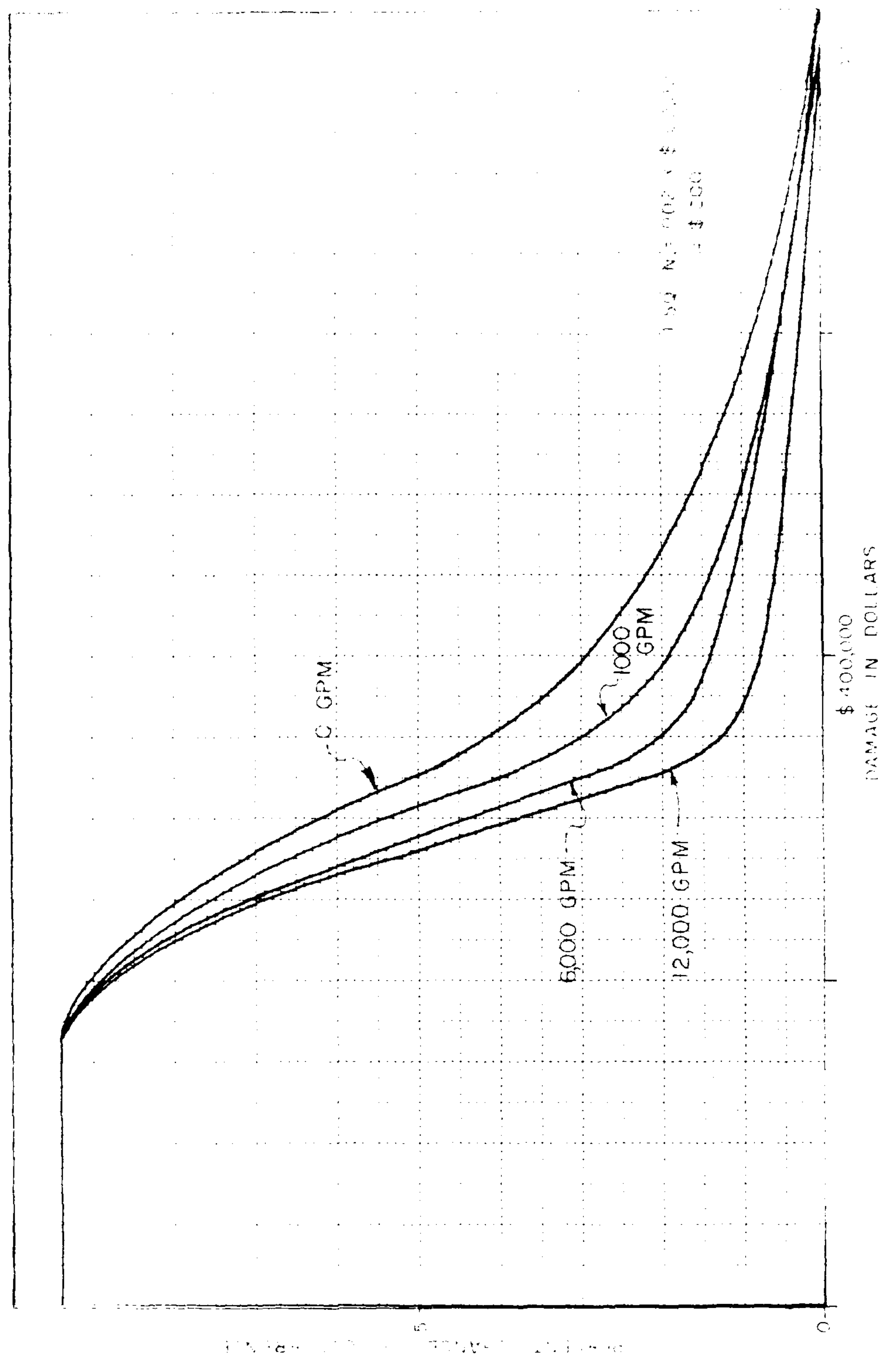
PUMP RATE GPM	AREA SQ. IN.	EST. AVG. ANN. DAMAGES	EST. AVG. ANN. BENEFITS
0	13.6	$ 2720	$ 0
5,000	11.0	2200	520
10,000	9.1	1820	900
20,000	5.8	1160	1560



FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM

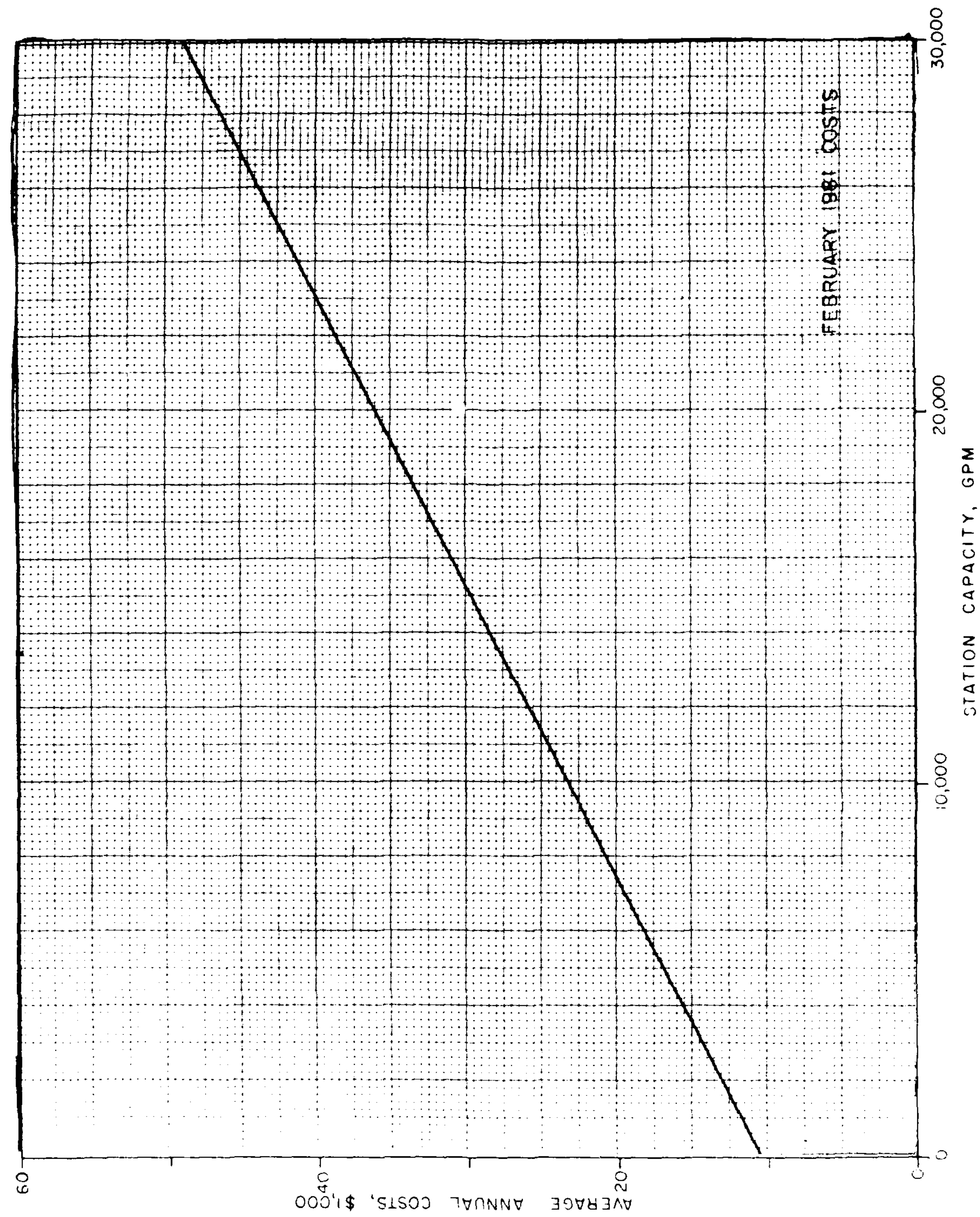
SECTION 3
DAMAGE - FREQUENCY CURVES

ST. PAUL DISTRICT



SECTION 2 & 3 COMBINED
DAMAGE - FREQUENCY CURVES

PLATE 4C-45



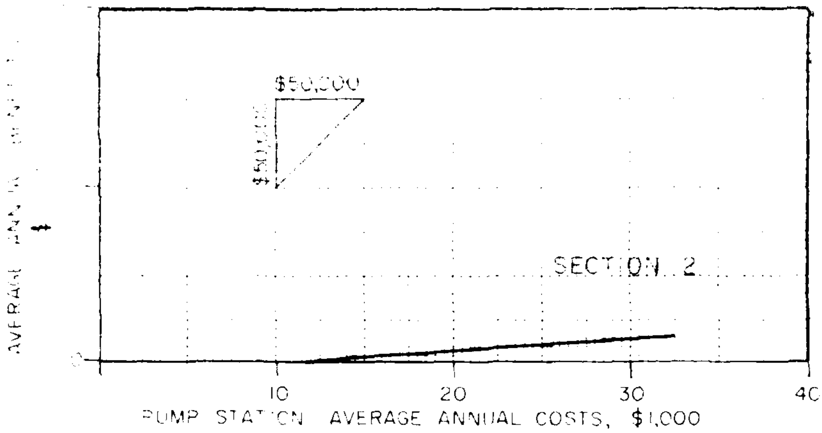
FLOOD CONTROL — MINNESOTA RIVER
CHASKA, MINNESOTA

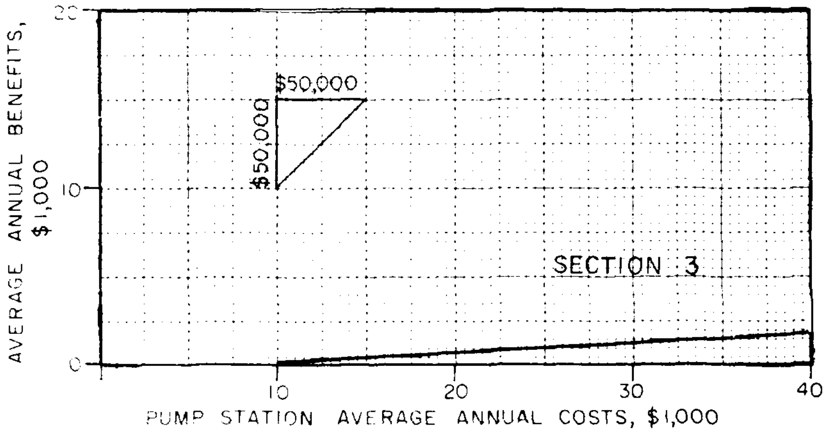
PHASE I GENERAL DESIGN MEMORANDUM

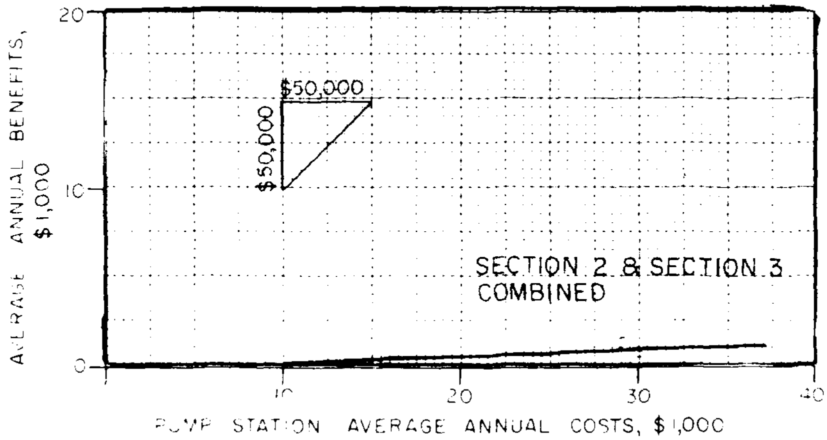
AVERAGE ANNUAL COSTS FOR VARIOUS PUMPING RATES

ST. PAUL DISTRICT

PLATE 4C-46







FLOOD CONTROL	MINNESOTA RIVER

CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

PUMPING STATION
BENEFIT-COST CURVES

ST PAUL DISTRICT

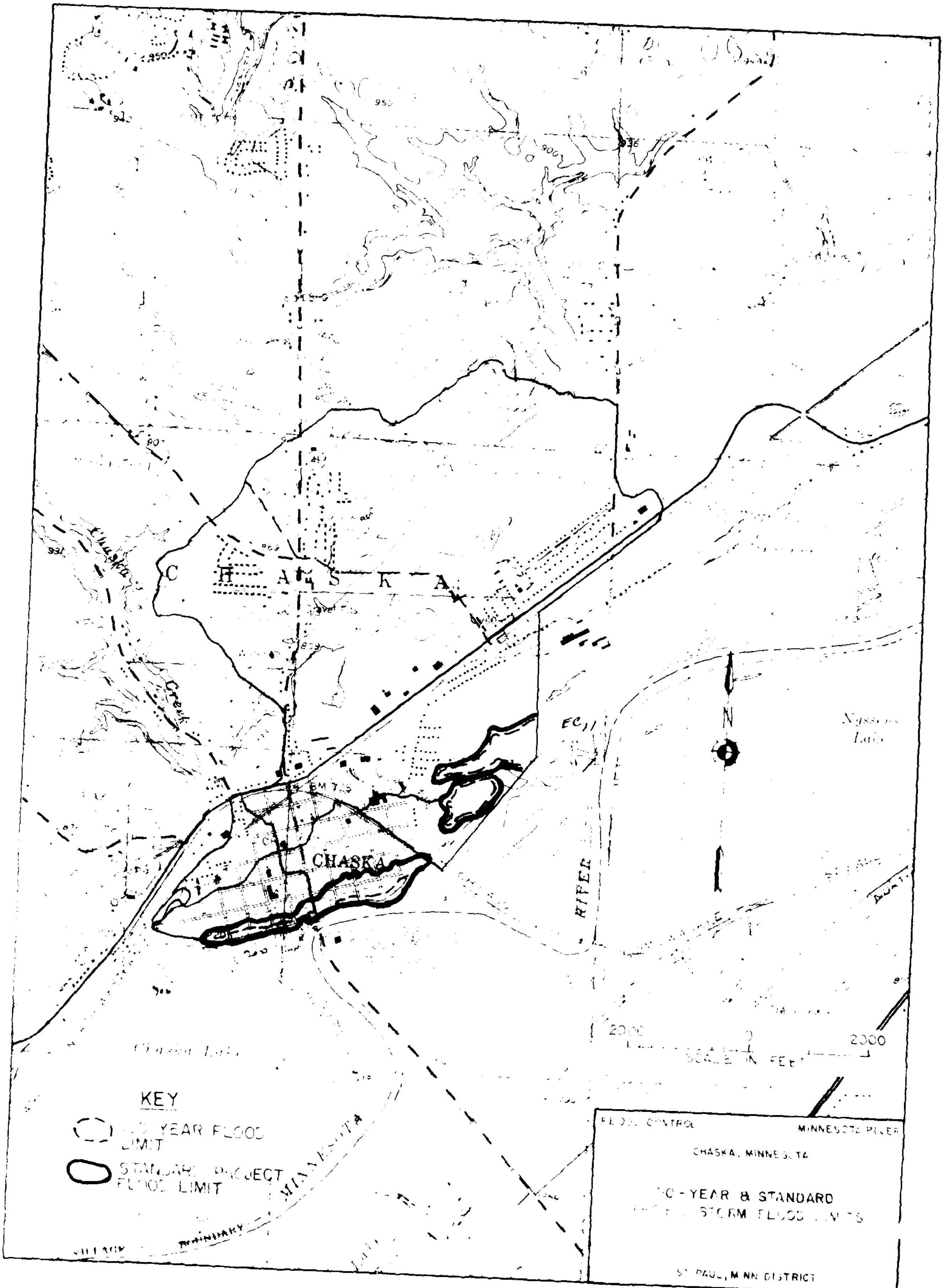

CHASKA
CHASKA
Chaska Creek
RIVER
Chaska Lake
MINNESOTA
KEY
YEAR FLOOD LIMIT
STANDARD PROJECT FLOOD LIMIT
2000
0
2000
SCALE IN FEET
N
FLOOD CONTROL
MINNESOTA RIVER
CHASKA, MINNESOTA
-YEAR & STANDARD
STORM FLOOD LIMITS
ST. PAUL, MINN DISTRICT

PLATE 4C-48

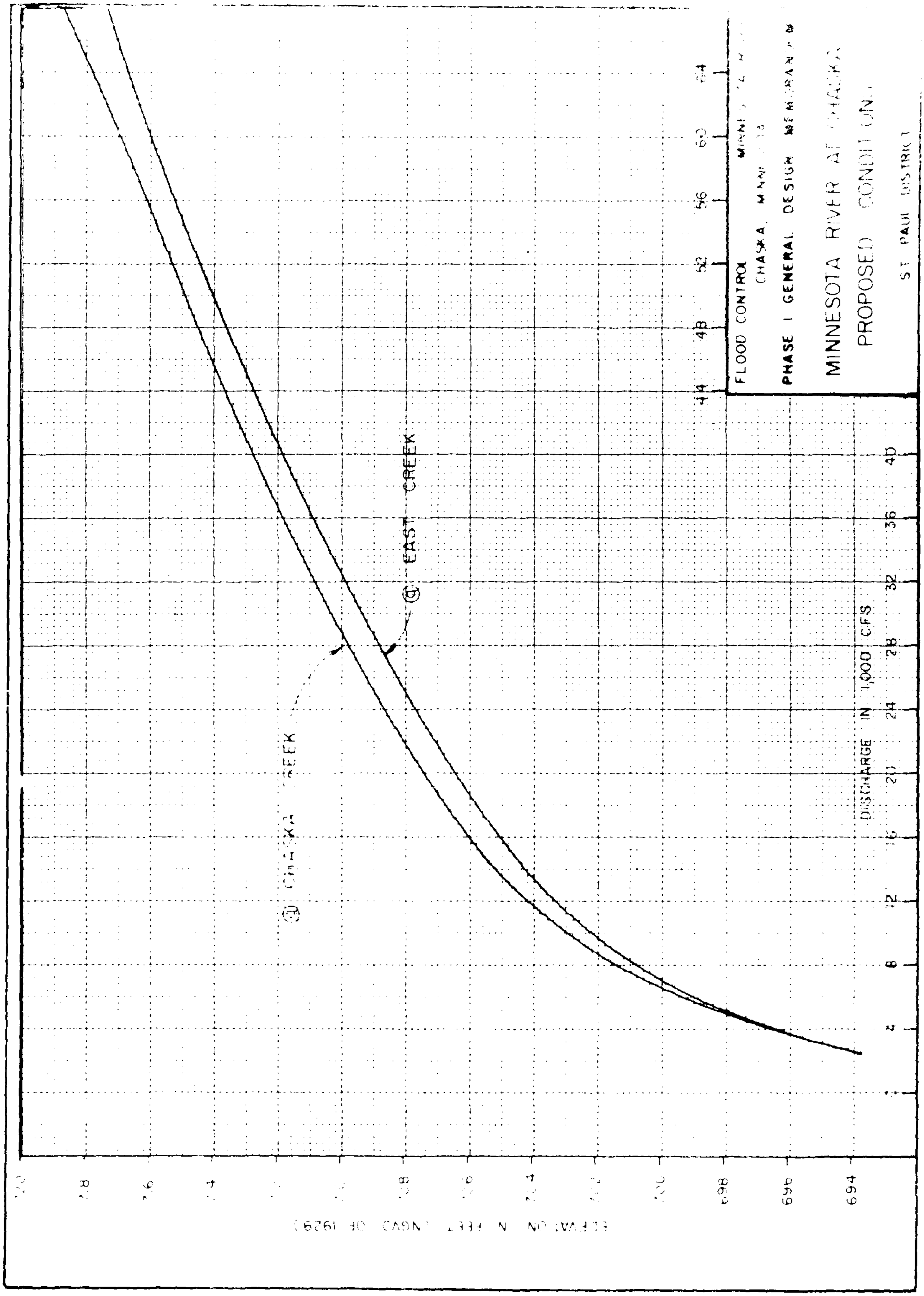

FLOOD CONTROL
PHASE I GENERAL DESIGN MEMORANDUM
MINNESOTA RIVER AT CHASKA
PROPOSED CONDITIONS
ST PAUL DISTRICT
EAST CREEK
DISCHARGE IN 1,000 C.F.S.
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
694
696
698

PLATE 4C-49

GEOTECHNICAL INVESTIGATIONS & DESIGN

APPENDIX

LIMITED REEVALUATION REPORT

MINNESOTA RIVER AT CHASKA, MINNESOTA

5

PREPARED BY THE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

TABLES

PLATES

TABLE OF CONTENTS (CONT.)

[illegible]

[illegible] The valley trends [illegible] and [illegible] miles wide [illegible]. The flood-plain lies at approximately elevation 705, averages 1 mile in width, and is characterized by extensive marshy areas and lakes. Alluvial and bedrock terraces rise above the floodplain and form regionally prominent benches at elevations 750 and 800. Most of the developed portion of Chaska is situated between elevations 710 and 750 at the upstream limit of a terrace that trends northeast along the base of the valley wall. The river valley walls rise sharply above the floodplain and terraces to form a bluff that grades into a hummocky, poorly-drained regional highland at elevation 850 on the north side of the valley and 900 on the south side of the valley.

Chaska Creek emerges from the regional highland in a deep, steep-walled valley on the northwest side of Chaska and flows in a shallow channel around the western and southern edges of the city to the Minnesota River. East Creek emerges from a similar but smaller valley onto a large terrace [illegible] 1.5 miles northeast of Chaska. [illegible] terrace, cuts through [illegible] [illegible]

The region surrounding the project area was glaciated several times during the Pleistoncene Epoch. The glaciers laid down thick deposits of outwash sands and unsorted tills that today form a hummocky, poorly-drained plain dotted with marshes and small lakes. The glacial drift reaches a thickness of 200 to 250 feet and rests on dolomitic limestone and sandstone of the Prairie du Chien and Jordan Formations. The large valley of the present Minnesota River was carved by the glacial River Warren, which carried large volumes of water discharging from the now-extinct glacial Lake Agassiz located in western Minnesota and eastern North Dakota. This river, the ancestor of the Minnesota River, cut deeply into bedrock and formed the terraces that are prominent today. As the flows decreased, the valley was filled to its present level with alluvial sand, silt, and soft clay.

The alluvial sediments under the existing levee consist primarily of fine and medium sand. Boring 73-1M, located near the mid-point of the existing levee, ended in the sand at a depth of 152 feet. Silt and clay are the dominant surficial materials under the proposed levee extension. Boring 73-3M located in this area penetrated 58 feet of silt and clay and ended in silty fine sand at a depth of 62 feet. Bedrock underlies the floodplain at a depth greater than 150 feet and is expected to be sandstone of the Franconia and Dresbach Formations. The broad floodplain and lower terrace levels are frequently flooded, poorly-drained, and characterized by a high water table.

SUBSURFACE INVESTIGATIONS

The initial investigation for the project was accomplished in March

1973 when nine borings were taken with a rotary drill. In May 1979, 12 additional rotary borings were taken. All of these borings were taken along or adjacent to the proposed Minnesota River levee alignment. In August 1980, eight rotary borings were taken along the alignments of the proposed diversion channels for the two creeks; three were taken through the existing levee; and two were taken in the vicinity of Courthouse Lake. Minnesota Department of Transportation borings were used to determine the depth to bedrock. The logs for the St. Paul District borings are shown on Plates 5-2 through 5-6, and the locations are shown on Plate 5-1. Test results may be found on Plates 5-15 through 5-47. The 1973 testing was performed by the North Central Division Lab, and the 1979 and 1980 testing by the Missouri River Division Lab. All test data are presented as received from the particular lab except as noted on the plates.

SUBSURFACE PROFILE

GENERAL

For purposes of design and analysis, the project has been divided into four reaches. Each reach represents a different type of design problem due either to the types of soils encountered in the initial boring program or the different types of physical features being designed. The Minnesota River levee has been divided into two reaches. The deep foundation along the proposed levee consists of alluvial sands and gravels. However, along the proposed alignment downstream from the abandoned C.M. St. P. & P. Railroad embankment is up to 25 feet of very soft, highly plastic clay at the surface which poses strength and settlement design problems. Upstream from the railroad, the levee will be founded primarily on sand where the main design problem is seepage and uplift. The diversion channels for the two

creeks are each considered to be separate reaches. Chaska Creek diversion is considered reach 3 and East Creek diversion reach 4. Reach 3 has a highly plastic clay layer throughout the reach. This CH layer contributes to stability problems in the narrow area between the M&St.L. Railroad and US Highway 212. As a result, a concrete rectangular channel is recommended from Sta. 11+00 to Sta. 34+00. This will eliminate stability problems to the highway and railroad embankments after construction is complete. Within reach 4, strength, stability and settlement problems could result at the downstream end of the diversion channel due to organic materials with high liquid limits and moisture contents (boring 80-34m). The concrete conduit beginning upstream of Flying Cloud Drive will significantly reduce the design problems caused by these poor soil conditions. The trapezoidal channel between the conduit exit and the Minnesota River will be in weak, saturated silts and silty sands. Overexcavation and backfilling or staged construction will probably be required in this area. This item will be investigated further in the detailed study phases.

Bedrock was not encountered anywhere in Chaska even though boring 79-10M was taken to a depth of 100 feet and boring 73-1M was taken to a depth of 152 feet. East of Chaska, the Minnesota Department of Transportation found bedrock at a depth of 170 feet, and near Carver, Minnesota, roughly 3 miles upstream, outcroppings of bedrock can be seen.

REACH 1

Reach 1 extends along Courthouse Lake from the northeast side of the lake (Sta. 0+00) to the abandoned C.M. St. P. & P. Railroad embankment (Sta. 30+00). This reach is the most critical portion of the proposed levee with respect to settlement and stability.

Five borings, 73-2M, 73-3M, 73-7M, 80-25M and 80-26M, were taken along the proposed alignment of the levee.

The borings indicate that soft foundation soils consisting of organic and inorganic clays of both high and low plasticity generally exist throughout the reach. The soft to very soft clays start at approximately elevation 700.0 and extend down approximately 25 feet or more before stiff clays are reached. Boring 73-3M shows a soft layer of highly plastic clay (CH), with a liquid limit of 82 and plastic limit of 30, extending down 18 feet from the ground surface. A soft to firm layer of low plasticity clay (CL), 10 feet in thickness, starts just below the uppermost CH layer. Blow counts vary between the weight of the hammer to 1, 2 and 4 blows per foot within the CH layer.

Local citizens have added fill along the proposed levee alignment between Sta. 17+00 and Sta. 30+00. Boring logs 80-25M and 80-26M give some indication as to type of fill added. Above elevation 700.0 the soils consist of silty sands, clayey sand and clayey gravels. A layer of low plasticity inorganic clay (CL) was also used as fill, as shown in boring 80-26M. Other borings within the flood control project show fill with concrete chunks and possibly other unsatisfactory material. If unsatisfactory fill was used along the levee alignment, excavation of the material will be required. During the Phase II report, additional investigations will determine if unsatisfactory fill was added. These investigations will include additional borings and laboratory testing.

REACH 2

This reach extends from the upstream end of the Minnesota River levee

Sta. [illegible] to the abandoned C.M.St. P&P. Railroad embankment (Sta. 50+00). This reach is the most critical portion of the proposed levee with respect to seepage control and uplift. The boring logs show a deep sand foundation overlain by a relatively thin semipervious blanket, having a thickness of about [illegible] to [illegible] feet. The blanket is made up of SC, GC, CL, OL, SM or some combination. Near the landward toe of the existing levee the blanket is [illegible] fill material. At boring 79-13M the Atterberg limits on the [illegible] the No. 40 sieve classify the fill as clayey sand (SC). [illegible] shows a layered blanket of fill 9.75 feet thick made up of [illegible] and [illegible]. The top elevation of the blanket is generally about elevation 71[illegible] feet; however, there are low areas behind the levee. Between Sta. [illegible] and Sta. 50+00 there are elevations as low as 704 feet. A semipervious fill will be needed to bring the blanket up to design thickness in these areas. Borings 73-4M, 80-23M, 80-24M and 80-25M were taken through the existing levee and show it to be essentially impervious, which is consistent with experience during the 1969 flood.

The boring logs also show that there is a thin impervious layer at a depth of [illegible] 25 to 35 feet. Soil tests on this material and the field descriptions (borings 73-1M, 73-5M, 73-6M, 79-12M, 79-13M and 79-14M) show it to be a silty clay or sandy silt (CL or ML). This layer is believed to be continuous, or nearly so, and should effectively limit the depth of the pervious layer considered in seepage computations. Experience with seepage and uplift during the 1969 flood seems to substantiate this assumption.

The effective grain size, "D_{10}," of the pervious layer at the proposed levee varies from 0.08 mm to 0.20 mm, with a weighted average of about 0.15 mm. Based on D_{10} the permeability can vary from greatest at the top to lowest at the bottom, or vice versa. The pervious material has from 4 to 12 percent fine material with the fine material averaging generally between 6 and 8 percent. There is also some gravel in the area. Downstream of the Minnesota Highway 41 bridge, boring 79-18M, approximately 1,200 feet landward of the levee, shows GP-GM in the upper 10 feet of the pervious layer with a D_{10} of 0.48 mm. Nearer to the river, borings 73-8M, 79-13M, 80-24M and 73-6M show from 2 to 8 percent gravel in the upper sand layers with D_{10}'s of about 0.18 to 0.20 mm, slightly higher than the weighted average. Upstream from the highway bridge boring 79-17M, about 475 feet landward of the levee, shows approximately 40 feet of uninterrupted sand and gravel, the upper 15 feet being classified as GP-GM with an effective grain size (D_{10}) of 0.2 mm. This gravel may or may not be evidence of old creek channels. There is evidence that the settlement and growth of Chaska included the rechanneling of both Chaska and East Creeks. This may need to be investigated further in the more detailed design phases.

Upstream of the Minnesota Highway 41 bridge, between Sta. 55+00 and Sta. 84+00, the pervious layer is not as thick or continuous, particularly in the line of borings nearest the landside toe of the existing emergency levee. Pervious sand layers are separated by layers of clay, silt and/or silty sand to depths over 50 feet (borings 73-1M, 79-19M, 73-5M, 80-23M and 79-20M). The second line of borings landward of the levee shows more sand than at the levee (73-4M, 79-15M, 79-16M and 79-17M).

Between Sta. 33+50 and Sta. 43+50 there is a riverside blanket which varies in thickness. There is only one boring riverward of the levee in

this area (79-22M) which shows a layer about 30 feet thick of impermeable material between the existing levee and the Minnesota River. This layer forms a seepage block between the levee and the river channel for the portion of the levee between Sta. 33+50 and Sta. 38+50. However, the topography and surveyed sections indicate that there is a borrow pit or old channel between the levee and the boring. Borings 79-12M and 79-22M suggest that the sands in the old channel or borrow pit are covered with a thin layer of silty sand (SM) 2.0 to 2.5 feet thick. There is also a riverside blanket between levee Sta. 57+00 and Sta. 84+00. Boring 79-21M shows 10 feet of ML, CH, CL and SM with thick layers of SP-SM. Chaska Creek closely parallels the existing levee from Sta. 73+00 to about Sta. 91+88 and appears to intersect pervious layers extending under the proposed levee providing an effective entrance for seepage.

REACH 3

This reach extends along Chaska Creek from a point just upstream of the confluence between the Minnesota River and Chaska Creek (Sta. 0+00) to a point upstream of US Highway 212 (Sta. 48+00). The most critical region within this reach, with respect to stability, lies within an area closely bounded by US Highway 212 and the M.&St.L. Railroad. The highway and railroads are built along the river valley walls which rise steeply to form a bluff at elevation 850 to 900. Three borings were taken along the diversion channel alignment (79-21M, 80-28M and 80-29M). All three borings have a layer of highly plastic inorganic clay (CH) separated by silty and clayey sands. The sandy dark gray inorganic clay (CH) varies between elevations 702 and 711. Boring 80-28M indicates that the clay layer is soft with a blow count of 3 blows per foot. Triaxial tests were performed on samples taken from boring 80-28M. These tests (R and S tests) indicate weak strength which is

reflected in stability analyses performed at Sta. 23+30 and Sta. 36+00. Sand layers classified as SC, SM, SP-SM and SP vary throughout the reach as shown by the borings. The uppermost layer consists of a blanket of silty sands, clayey sands or poorly graded sands with varying strengths. Boring 80-29M has approximately 10 feet of poorly graded sand (SP) with blow counts of 4 blows per foot. Boring 80-28M has approximately 10 feet of poorly graded silty sand of 17 blows per foot. Below the uppermost blanket, a layer of silty, dark gray inorganic clay (CL), 4 feet thick appears in boring 80-28M. This relatively weak layer contributes to instability along the proposed rectangular channel. Boring 79-21M is the only boring between Sta. 0+00 and Sta. 17+00. This boring shows layers of laminated or varied clay of low to medium plasticity. Field tests indicate that the clay layers have blow counts varying between 2 and 24 blows per foot. The weakest clay layer is located between 8.5 feet of silty sand and 4.0 feet of silty, organic dark gray peat, clay mixture. The silty sand is relatively strong with a blow count of 24 blows per foot. Sand lenses of varying thicknesses consisting of poorly graded silty sand are scattered throughout the boring. Stability is not considered critical through this part of the reach; however, during the Phase II report, additional testing is required throughout the entire reach, especially between Sta. 17+00 and Sta. 56+00. At that time additional analyses will be performed to confirm assumptions made for this report.

REACH 4

Reach 4 extends from the bluffs of the Minnesota River Valley (Sta. [illegible]) to the east of Chaska (Sta. 0+00). Five borings were taken within this reach:

80-30M, 80-31M, 80-32M, 80-33, and 80-34M. Boring 80-33M is located just upstream of the proposed diversion structure on East Creek; 80-32M is just east of County Road 17; 80-31M is southeast of boring 80-32M. These three borings have similar characteristics. Alternating layers of inorganic clay (CL), clayey sand (SC) and poorly graded sand (SP) are common throughout the area. Blow counts range from 1 to 12 blows per foot. Boring 80-32M has 2 blows per foot for most of the boring, while 80-31M varies between 1 and 8 blows per foot. Mechanical analysis and Atterberg limits were performed on soil samples throughout the reach. These tests are shown on Plate 5-26. Borings and the proposed channel design indicate that stability and settlement are not considered critical above the proposed concrete conduit. Boring 80-30M is located between Flying Cloud Drive and the C & NW Railroad. This boring shows approximately 60 feet of sand and gravel. Boring 80-34M, which is located on a bench approximately 800 feet from the Minnesota River consists mostly of organic material of high plasticity from the ground surface (el. 720.4) to approximately elevation 697. Minnesota Department of Transportation boring T4 taken in 1963 is along the Minnesota River in the vicinity of the stilling basin. Boring T4 consists of wet soils classified as silt (ML), silty sand (SM), poorly graded sand (SP) and gravel (GP), with silt (ML) of very low strengths (blow counts of 1 BPF) at a depth 14 feet to 27 feet from ground surface. Borings T4 and 80-34M indicate that design problems may exist; however, the proposed concrete conduit passes under or through the organic material, and excavation of low strength silt (approximately twice the normal amount) and replacing the silt with suitable material along the riprapped channel and stilling basin will effectively solve the design problem caused by poor soil conditions.

EXTENT OF DESIGN ANALYSIS

The analysis contained in this appendix was directed at assessing problems and identifying possible alternative solutions which would have a major impact upon project costs. Detailed analysis for each of the reaches will be done during the preparation of the phase II general design memorandum and any feature design memorandums which become appropriate.

PROJECT FEATURES

GENERAL

The proposed improvements at Chaska consist of a 0.9-mile diversion channel for Chaska Creek, a 0.92-mile diversion channel for East Creek, three drop structures for Chaska Creek, five drop structures for East Creek, two new bridges, 0.87 mile of levee upgrading, 0.64 mile of new levee, one pumping station, a recreational trail system, and general landscaping and tree planting in construction areas. The plan also includes floodplain regulation on East Creek near U.S. Highway 212, on Chaska Creek upstream from the diversion channel, in ponding areas needed for interior drainage, and along the Minnesota River outside the leveed area. Plate 1 of the main report provides pertinent information on the location, limits and types of improvement being proposed. The project features are designed to provide Chaska with protection against the 100-year flood on the Minnesota River and the standard project floods on East Creek and Chaska Creek.

EXISTING LEVEE

Since 1965 the existing levee at Chaska has been raised on numerous occasions, usually under emergency operating conditions either during or following a flood. For this reason, there has always been a tendency to raise the levee by adding more fill to the top than to the side slopes. As a result, the existing levee is overly steep in the side slopes and does not meet Corps stability criteria.

Since 1969 levee deficiencies observed or analyzed include slope stability, seepage, erosion, and maintenance problems due to steep slopes. Initial boring information indicates that the material used in the construction of the emergency levee is basically suitable material, if placed under controlled conditions. However, the material placed during emergency construction was placed in a random matter, with emphasis on placing as much material as possible in a short period of time, assuming that potential weaknesses in the structure could be handled as they developed. It is anticipated several additional borings and test data will be required to fully evaluate the existing levees.

The present plan is to use the majority of the existing levee fill in the proposed levee. The existing levee will be stripped of topsoil, grass, and trees and provided with an inspection trench to allow visual classification of material and in situ testing. In areas with suitable material meeting the design criteria the permanent levee will incorporate the existing levee. In areas with unsuitable material, the existing levee will be removed or reworked to meet design criteria. In other areas the

emergency levee will be shifted landward, which will allow inspection of the existing levee material. During the phase II design, the details will be closely analyzed.

EXISTING LEVEE STABILITY

Slope stability analysis indicates that the emergency levee does not meet Corps criteria for a steady seepage and partial pool condition. Both the landward and riverward slopes have factors of safety below the Corps requirement of 1.4. The landward factor of safety is as low as 0.985, while the riverward factor of safety was as low as 1.133. In the past the existing levee has experienced shallow slides on the landward side, erosion along the toe of the primary bank upstream and downstream of the Highway 41 bridge, and seepage under the levee. When all these factors are considered, the integrity of the existing levee cannot be assured or predicted.

PROPOSED FLOOD BYPASS AND DIVERSION CHANNELS

Bypassing flood flows from the natural channels of East Creek and Chaska Creek is a major element in the proposed plan (see main report, Plate 7-1). The diversion channel proposed for East Creek consists of 1,060 feet of riprap trapezoidal channel, 1,410 feet of 16-foot diameter conduit, and 2,160 feet of grass-lined earth trapezoidal channel with riprapped bends. The drop structures consist of a St. Anthony Falls straight drop spillway stilling basin, a flared side wall spillway and stilling basin, a modified St. Anthony Falls straight drop spillway and stilling basin, and the CIT type drop structure. The 0.92-mile bypass channel used for East Creek would start on a bench of the Minnesota River valley and end at the Minnesota

River just east of Chaska (see main report, Plate 7-1). The concrete drop structures would reduce design flow velocities to the point where lining the channel with rock would prevent streambank erosion. Normal low flows on East Creek would be maintained in the natural channel by the diversion structure.

The 0.9-mile Chaska Creek channel improvement would start about 400 feet upstream from US Highway 212. Just downstream of US 212 the channel would be realigned to pass through a sparsely developed industrial zone along the western side of Chaska to the Minnesota River floodplain (see main report, plate [illegible]).

Approximately 400 feet of concrete trapezoidal channel would be required upstream from US Highway 212; 2,400 feet of riprapped trapezoidal channel and 2,5[illegible] feet of concrete rectangular channel will complete the Chaska Creek improvement. Three drop structures would be required to control channel gradient and prevent erosion. A recreation trail along the channel would provide a link between the Minnesota River Valley Trail System and streamside open space areas being acquired by Chaska.

PROPOSED LEVEE

The proposed levee would generally follow the alignment of the existing levee except at specific locations where the levee must be shifted slightly to avoid existing structures, shifted landward due to excessive encroachment on the Minnesota River, or shifted riverward of Courthouse Lake to provide ponding for internal drainage. The proposed levee would be 2 feet higher than the existing levee for the 1.0 percent flood, which is the design

flood, and 6.0 feet higher for the standard project flood. The existing levee will be used as fill for the proposed levee if the material composed of SM, SC, ML, C or some combination can meet the design criteria. The levee would be designed to be impervious, with side slopes of 1V on 3H with a 10-foot top width.

SLOPE STABILITY AND SETTLEMENT

SELECTION OF CRITICAL SECTION

Slope stability analyses were performed at Sta. 13+50 (reach 1), Sta. 52+00 (reach 2), Sta. 23+30 (reach 3), and Sta. 36+00 (reach 3). All other sections were considered less critical. The levee foundation at Sta. 13+50 is typical of the highly plastic clays found in reach 1. In areas where fill was added by local citizens, sufficient data were not available for slope stability analyses. The levee at Sta. 52+00 is typical of soils found in this reach. Two sections are considered critical in reach 3, at Sta. 23+30 and Sta. 36+00. Station 23+00 is critical because the diversion channel is cramped between U.S. Highway 212 and M&St.L. Railroad. Station 23+30 is within the narrowest part of the reach where the valley slopes are the steepest. Boring 80-28M is close to the section analyzed, and shows the highly plastic clay found throughout the reach. The stability of the trapezoidal channel was analyzed at Sta. 36+00. The analysis was performed to check stability of the channel in this section vs. stability of the channel at Sta. 23+30. It was determined that upstream of channel Sta. 30+00 the highway and railroad embankments have little effect on channel slope stability because of the change in topography. A riprapped, earth trapezoidal channel, therefore, would satisfy EM 1110-2-1913 criteria.

PARAMETER DETERMINATION

When the critical sections in each reach were analyzed for stability, parameters representing soil conditions were determined by a combination of factors. When available, the results of triaxial tests were used. Atterberg limits were performed on a large percentage of borings in the critical stability areas, and the results obtained from these tests were used to determine shear strength, cohesion, and internal friction angle. Where engineering judgment was used, estimates were kept conservative. During the Phase II report, critical slope stability problem areas will have additional laboratory testing. At that time, further analysis (if required) will be based on these additional data.

DETERMINATION OF CRITICAL SAFETY FACTORS

The Sta. 13+50 (reach 1) slope stability model is shown on plate 5-9. The analysis utilized the St. Paul District's computer program 741-F5-F030, entitled "Circular Failure with Side Force." The weak foundation clays were considered homogeneous, with soil parameters taken from tables found in "Foundation Engineering" by Peck, Hanson and Thornburn. As outlined in EM 1110-2-1913, the end of construction design condition was utilized. The results of the analysis, as shown on plate 5-9, show safety factors of 1.35, 1.30, and 1.38. These values meet the safety factor of 1.30 for the end of construction case as shown on Table 6-1 of EM 1110-2-1913.

The Sta. 52+00 (reach 2) slope stability model is shown on plate 5-7. The St. Paul District's computer program 741-F5-F020, entitled "Generalized Failure Surface," was utilized for this analysis. As shown on plate 5-7, boring log 79-14M represents the subsurface conditions. Soil parameters were determined by engineering judgment based on Atterberg limits and textural classifications. End of construction design condition, as shown in EM 1110-2-1902, was utilized. Table 1, shown in EM 1110-2-1902, indicates that a safety factor of 1.30 must be reached for stable slopes. The results of the analysis indicate that a safety factor of 1.49 was reached.

The slope stability model for Sta. 23+30 was not drawn on a plate for this report. The St. Paul District's computer programs 741-F5-F030 and 741-F-020 were utilized during the analysis. As indicated previously in this report, the diversion channel is cramped between the U.S. Highway 212 embankment and the M&St. L. Railroad embankment. The topography of the area was represented during the analysis; boring 80-28M was utilized for the subsurface profile; in areas where road fill composition had to be assumed because of the lack of boring data, the soil was classified as CL. The soil parameters were determined from triaxial R and S tests taken on samples from boring 80-28M. The Q test was not available and engineering judgment was utilized based on the R and S tests. Live loads due to rail traffic were also considered in the analysis. The proposed channel design is a concrete rectangular channel; therefore, stability of the embankments during excavation and construction is the main problem considered in the analysis. The model attempted to represent excavation needed for placing of concrete form work. The results of the analysis indicate a safety factor of 0.97 for

the highway embankment and 0.98 for the railroad embankment. Shoring of the construction site and staged construction (excavation, construction, and backfill in 50-foot sections) will probably be required. During the Phase II report additional borings will be taken and triaxial testing performed. This information will be used in further slope stability analyses.

The Sta. 36+00 (reach 3) model used St. Paul District's computer program 741-F5-F020. The model utilized during the analysis is shown on plate 5-8. Boring 80-28M was used for the subsurface profile, with slightly increased shear strength values for the two clay layers. The shear strengths are not as conservative as for Sta. 23+30, because of the change in geologic topography (also, it is believed that the CL layer is pinched out within the upper part of the reach as boring 80-29M indicates). End of construction design conditions, as outlined in EM 1110-2-1913, were followed during the analysis. The analysis resulted in a safety factor of 2.16 for the highway embankment. This is larger than the safety factor of 1.30 shown in Table 1 of EM 1110-2-1902. Further analyses will be completed during the Phase II report if additional testing indicates that assumptions made for this report are erroneous.

SETTLEMENT ANALYSIS

Settlement of the Courthouse Lake levee (reach 1) is significant from Sta. 0+00 to Sta. 18+00. The borings show 20 to 25 feet of soft to very soft clay along the levee alignment. Plate 5-9 summarizes the settlement results obtained near Sta. 13+50. One dimensional consolidation is assumed; compression indexes for clays were determined using Skempton's liquid limit

correlation. Laboratory consolidation tests were not available; therefore, field or virgin compression curves were not utilized. One single homogeneous layer of inorganic clay 27.5 feet thick overlying an impervious layer was assumed. As shown in boring 79-3M, very stiff clays start approximately 25 feet below the surface; therefore, further consolidation of the stiff clays is assumed negligible. Total settlement of 3.4 feet was determined at Sta. 13+50; therefore, staged construction of the levee over 12 to 18 months is likely. Settlement problems in other reaches are not considered critical; however, drop structures will be analyzed for settlement in the Phase II report when sufficient data are available. Most of the structures will be founded on sand, and settlement should not be a problem.

SEEPAGE AND UPLIFT ANALYSIS

The boring logs indicate that seepage would be a problem for reach 2 of the proposed levee. During the 1969 flood, when the water was near the top of the existing levee, underseepage was observed landward of the levee in this area. There was some heaving of bituminous paved area, but seepage through the existing levee and piping in the form of sand boils was not observed. Records indicate that about 20,000 gpm (gallons per minute) were pumped during the peak of the 1969 flood. However, this 20,000 gpm included sanitary wastewater and groundwater infiltration to the sanitary system plus other interior runoff. Precipitation records at Minneapolis show that precipitation fell on the 8th, 11th, 15th and 16th of April 1969. A rough estimate of seepage quantities would thus be between 5,000 and 10,000 gpm.

For this study two alternative designs were developed for the 1.0-percent flood. The most cost effective design was then scaled upward by extrapolation for the standard project flood. The first alternative design

calls for a system of sand berms to control seepage throughout reach 2. The second alternative calls for sand berms between Sta. 55+00 and Sta. 78+00 upstream of the Minnesota Highway 41 bridge, and between Sta. 33+50 and Sta. 38+50 downstream of the bridge. For the most critical portion of the levee, between Sta. 38+50 and Sta. 53+50, a system of relief wells was designed. The second alternative is the least costly and the one recommended for the project.

The berms were designed using the methods of EM 1110-2-1913 and TM 5-424. Six cross sections of the existing levee, including both landward and riverward areas, were drawn from existing topography or were actually surveyed. The appropriate boring logs and design levee sections were superimposed on these sections and the design computations were made. Plate 5-10 demonstrates the design method for section 4, which is at Sta. 47+25 in the middle of the most critical reach of levee with respect to seepage and uplift control. Table 5-1 shows the results of the berm design alternative at all the sections. Section 1A was drawn using the existing topography and assuming the pervious layer extends as deeply as at boring 79-17M (i.e., to elevation 674). This assumption was made to determine the effect of an assumed buried channel in this area. The flood level was assumed to be at the top of the proposed levee for design against uplift pressures and at the design water surface elevation for the computation of seepage quantities. The seepage quantities for the berm design alternative are shown in Table 5-2.

A computer program was used to design relief wells between Sta. 38+50 and Sta. 53+50 as an alternative to the berm design in this area. The title of the program is "Design for Infinite System of Relief Wells,"

Reference File No. 741-6X-F5050. The program determines the relief well spacing for given penetrations into the pervious substratum generally as suggested by the Waterways Experiment Station Technical Memorandum No. 3-424, Volume 1. The variables shown on the computer output (plate 5-5) are defined in table 5.5. The program computes the factor of safety for the given condition to determine the necessity for relief wells, peizometers, or no relief wells. When relief wells are required, the program designs the relief well spacing vs. penetration into the aquifer for conditions with or without a landward top semipervious stratum and can compute seepage quantities for the design conditions.

Average horizontal permeabilities of the pervious strata and vertical permeabilities of the top strata were determined by the methods shown on Plate 5-10 which demonstrates the berm design methodology. A single average horizontal permeability, thickness of pervious layer, vertical permeability and thickness of top layer were used for the whole reach between Sta. 38+50 and Sta. 53+50 for relief well design. The top layer was taken to be an SC for the entire reach. A sensitivity analysis was made utilizing the computer program to determine which parameters had the most effect on well spacing for the design reach. The two variables that had the most effect were the distance from the landside levee toe to the effective seepage entrance(s) and the moist unit weight of the top layer. This result is due primarily to the fact that the thicknesses of the pervious layer and top layer vary only 10 to 15 percent and the average permeability of the pervious layer (based on D_{10} grain sizes) is almost constant. Plates 5-11 through 5-14 show the typical section and sample input and output (computer) for the relief well design.

The layout of wells to fit features of the area resulted in a lesser well

spacing in some cases than indicated in the design. No adjustment of well spacing from the computed infinite well system was deemed necessary at the center of the line of wells to fit the existing finite system. However, a half spacing was provided at extreme upstream end of the line of wells to bring the possibly higher pressures within reasonable limits. At the downstream end of the line of wells the well spacing was considered conservative as computed because the distance from the landside toe of the proposed levee to effective seepage entrance is considerably increased. The required well spacing (1.0-percent flood) between Sta. 38+50 and Sta. 53+50 was computed to be 67.5 feet. Between Sta. 33+50 and Sta. 38+50 the computed spacing was 250 feet, and a factor of safety of 12 was computed without wells. Therefore, the spacing of 65 feet, which is recommended for the reach (except for the first three upstream), is considered conservative enough for the downstream end. A summary of the well design for both the 1.0-percent flood and SPF is shown in Table 5-4. As can be seen on the computer output (Plate 5-14), seepage for the SPF is slightly higher than for the 1.0-percent flood. The required well spacing (SPF) between Sta. 38+50 and Sta. 53+50 was computed to be 62.5 feet; therefore, the spacing of 65 feet is considered adequate for the SPF. For the reach 54+50 to 83+50, the total seepage for the 1.0-percent flood design would be 1,830 gpm. For the reach 33+50 to 53+50 the seepage would be 3,510 gpm.

LEVEE SECTION, RELIEF WELL AND GROUND SURFACE ELEVATIONS (STA. 38+50 TO STA. 53+50)

The relief wells will be placed at the toe of the proposed levee. All landside elevations should be raised to at least 710.0 feet (N.G.V.D., 1929 Adj.). Fill material would be SC to be compatible with assumptions made during design.

The top of the riser pipe should be placed at elevation 708.00. The top elevation of the collector pipe should not exceed the elevation of the top of the riser.

The levee section would have a riverside slope of 1V to 3H, a minimum top width of 10 ft., and a constant top elevation of 728.00. The landside levee slope would also be 1V to 3H; however, at approximately elevation 713.5 a berm with a 1V to 10H slope and total width of 20 ft. would begin. This berm would extend only about 9 feet beyond the toe of the levee without the berm, and, except in the vicinity of a well, could be adjusted slightly to fit around structures. The berm would be terminated with a 1V to 3H slope and should be constructed with the same impervious material as the levee. The main purpose of this small berm is to provide soil depth to resist freezing, but it will also mark definitely a line beyond which development may not proceed.

SLOPE PROTECTION

The landward slope and top of levee and slopes of ditches and ramps would be covered with 4 inches of topsoil and seeded. Twelve inches of riprap with 18 inches of filter material (two-staged filter) will be placed along the Minnesota River levee from Sta. 40+00 to 54+00 and Sta. 20+00 to 31+00. The preliminary design for East Creek and Chaska Creek Diversion channels will require 12 inches of riprap protection combined with an 18-inch filter blanket(two-staged filter) where riprap is required. Typical levee and channel riprap sections are outlined on Plates 5-4 through 5-10 of the main report.

DISPOSAL

Excavated material from beneath the levee extension reach would be used in landward or riverward berms wherever space permits. Suitable material excavated from the diversion and bypass channels would be utilized in the proposed levee and East Creek bypass structure embankments. Excess material from channel excavations would be disposed of in overburden areas

as part of the expansion of recreational areas in the vicinity of Courthouse Lake. Other potential disposal areas, if required, include fill areas in the Jonathan development and proposed new Highway 41 embankment area. However, final selection of suitable disposal areas would be determined during advanced planning, if needed.

SOURCE OF CONSTRUCTION MATERIALS

RIPRAP AND BEDDING

Riprap and bedding of adequate quality could be obtained from limestone quarries in the Prairie du Chien formation located on the south side of the Minnesota River valley within 10 miles of Chaska.

CONCRETE AGGREGATE

Concrete aggregate of adequate quality could be obtained from continuously operating natural aggregate and crushed rock sources in the Minneapolis-St. Paul metropolitan area. The distance from the project to reliable sources in this area would be 25 to 50 miles. Closer sources located within 10 miles of Chaska exist but produce concrete aggregate on an intermittent basis. Although the closer sources have not been tested or used for Corps of Engineer projects, information obtained from the Minnesota Department of Highways indicates this material would be adequate as a concrete aggregate.

LEVEE FILL

Levee fill would consist of impervious glacial till obtained from the diversion and bypass channel excavations. A plentiful supply of impervious glacial till deposits is available from the surrounding uplands in the event sufficient quantities are not obtainable from channel excavations.

Table 5-1

Summary of Berm Design Computations
for 1.0 Percent Flood and Standard Project Flood

Station (ft.)	Cross Section	Applicable Borings	Berm Width (ft.)		Thickness of Berm at Toe of Levee (ft.)		Thickness of Berm at Crown (ft.)	
			100 yr	SPF	100 yr	SPF	100 yr	SPF
73+20	1	79-21M 79-17M	27(1)		3.0		2.5	
69+00	1A	79-17M	27	32.0	3.0	3.5	2.5	2.5
63+20	2	79-19M 79-16M	27(2)		3.0		2.5	
56+50	2A	73-1M 79-15M	20(3)	36.0	3.5	3.5	2.5	2.5
51+70	3	79-14M	121	156	5.0	6.0	2.5	2.9
47+25	4	79-13M 73-8M 79-18M	127	140	5.0	5.1	2.5	2.5
35+00	5	79-22M 79-12M 79-11M	20(3)	30	3.0	3.0	2.5	2.5

(1) Existing creek channel that parallels levee will be filled with impervious material. Use same berm as at Section 1A.
(2) Use same berm as at Section 1A.
(3) Use minimum sand berm width of 20 feet.

Table 5-2

Seepage Calculations for
Berm Design Alternative

(1 Percent and Standard Project Flood)

$$Q_s = Mk_f d; \quad M = \frac{ho' - ha}{X_s}$$

1 Percent Flood

Section No.	ho' (ft)	ha (ft)	X_s (ft)	M (ft/ft)	K_f (fpm)	d (ft)	Qs (gpm/ft)
1A	4.91	3.20	27	0.0633	0.060	29.5	0.84
2A	4.80	3.84	20	0.0480	0.056	22.3	0.45
3	8.40	3.20	121	0.0430	0.075	30.9	0.75
4	8.78	3.36	127	0.0439	0.071	34.9	0.81
5	7.60	6.60	20	0.050	0.157	24.5	1.44

Standard Project Flood

Section No.	ho' (ft)	ha (ft)	X_s (ft)	M (ft/ft)	K_f (fpm)	d (ft)	Qs (gpm/ft)
1A	5.56	3.20	31.6	0.0747	0.060	29.5	0.99
2A	7.10	4.80	36.0	0.0639	0.056	22.3	0.60
3	10.50	3.20	156.0	0.0468	0.075	30.9	0.81
4	9.49	3.36	140.0	0.0438	0.071	34.9	0.81
5	8.28	6.60	32.6	0.0515	0.157	24.5	1.48

Table 5-3

Seepage Quantities for
Berm Design

Station (ft)	Q_s (gpm/ft) 100 yr	Q_s (gpm/ft) SPF	Total Discharge (gpm) 100 yr	Total Discharge (gpm) SPF
*83+50-77+50	-		250	250
77+50-63+50	0.84	0.92	1180	129
63+50-54+50	0.45	0.80	400	542
54+50-53+50	Hwy. 41 Embankment			
53+50-49+50	0.75	0.81	300	325
49+50-38+50	0.79	0.81	890	890
38+50-33+50	1.44	1.48	720	745
		Total	3740	4235

* Estimate. See borings 79-20M and 73-4M, seepage not a problem.

Table 5-4

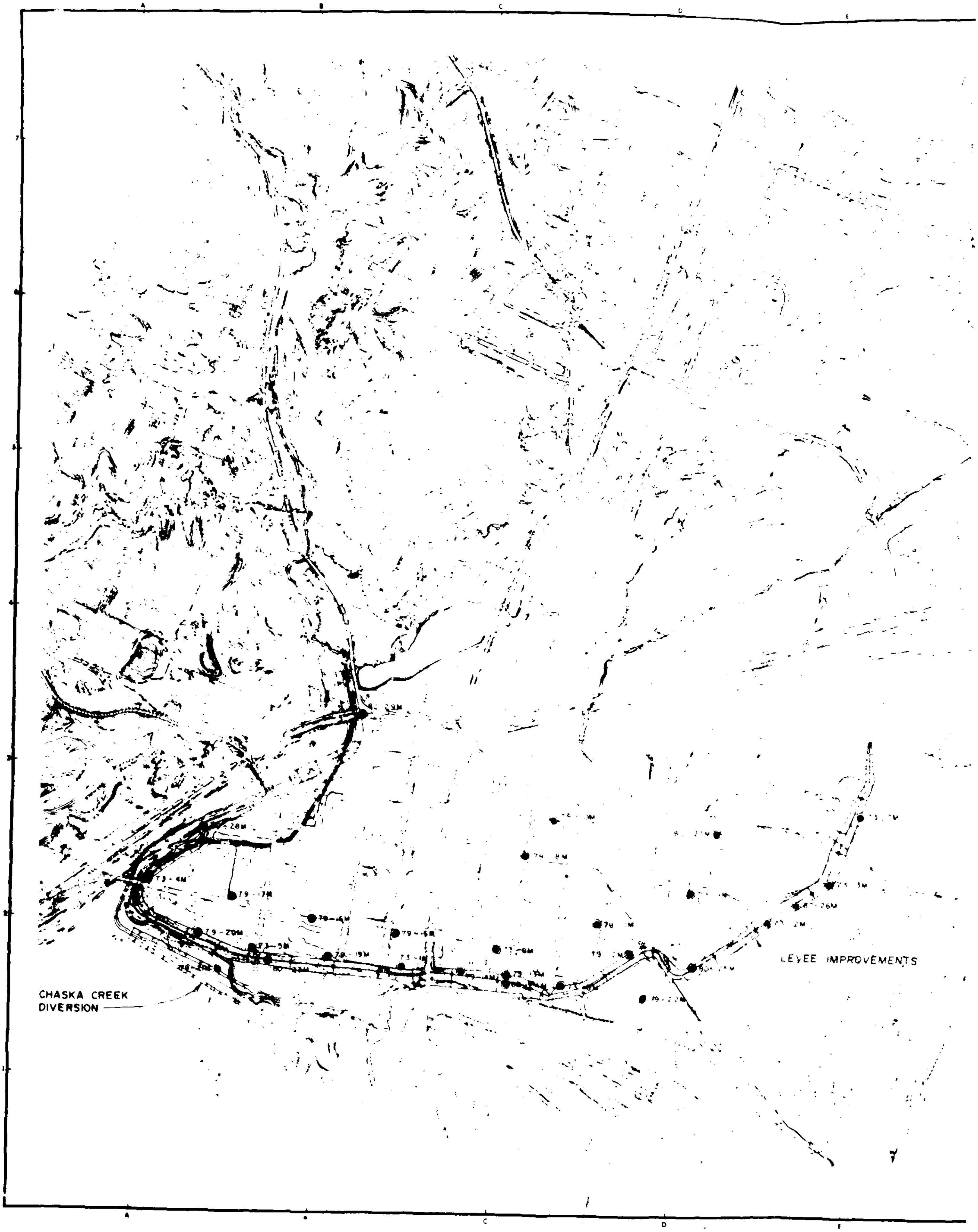
Summary of Relief Well Design

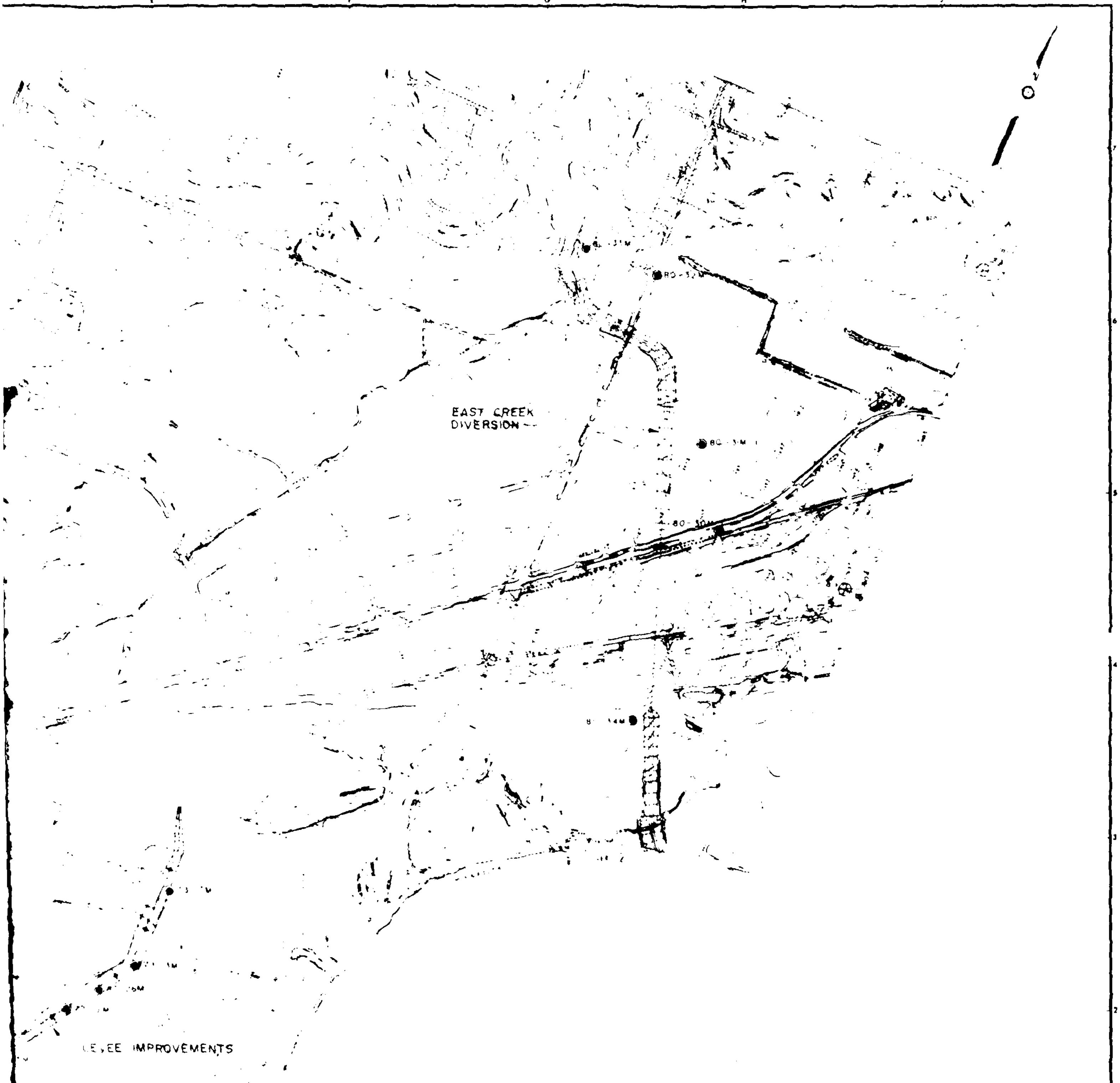
Degree of Protection	Station (ft.)	Spacing (ft.)	Depth (ft.)	Depth Well Screen (ft.)	Elevation Top Riser (ft.)	Diameter Well Point (in.)*	Gravel Pack (in.)	No. Wells
100 yr.	52+82 to 53+50	34	35	31	708.0	8.0	6.0	3
	38+50 to 50+25	65	35	31	703.0	8.0	6.0	21
SPF	52+87.5 to 53+50	34	35	31	708.0	8.0	6.0	3
	38+50 to 52+25	65	35	31	708.0	8.0	6.0	21

* Well point may be a well screen of plastic or fiberglass.

Table 5-5 - Definitions of variables

Datum	-	Elevation of ground surface at landside levee toe (feet above NGVD)
D	-	Thickness of pervious sublayer
FK	-	Coefficient of permeability of pervious sublayer. Normally called K_f (fpm).
X3	-	Distance from landside levee toe to effective seepage exit (ft.)
S	-	Distance from landside levee toe to effective seepage entry (ft.)
H	-	Height of levee above Datum (ft)
WHT	-	Difference in elevation between Datum and top of riser pipe. May be (+) or (-) (ft.).
RL	-	Length of riser pipe above well screen (ft)
DIA	-	Inside diameter of well screen (in.)
RW	-	Effective radius of well screen and surrounding gravel pack (ft)
FREE	-	Design freeboard on levee (ft.)
WDI	-	Penetration of well into pervious sublayer (%/100)
F	-	Design factor of safety for relief wells
ZT(I)	-	Effective layer thickness for uplift for semipervious layer (I= 1,4) (ft.)
GAM(I)	-	Unit weights corresponding to ZT(I) for uplift computations (pcf)
KBL	-	Coefficient of vertical permeability for semipervious blanket (fpm)
F.S.	-	Existing factor of safety against uplift
SP	-	Well spacing (ft)
QW	-	Total flow into each well with water surface at top of levee (gpm)
HW	-	Elevation of top of riser pipe plus all head losses in the well minus the datum elevation, may be (+) or (-) (ft.)
HAVI	-	Net average head in plane of measured above HW (ft)
TMI	-	Midpoint uplift factor
QUEW	-	Flow into wells per foot of reach with water surface the distance FREE below the top of levee (gpm)
QS	-	Total seepage flow which passes the levee with the water surface FREE below the top of the levee (gpm)
R	-	Extra length beyond ends of wells for use in calculating total seepage intercepted by wells (ft.)
HWI	-	Net head beneath top stratum at midpoint between wells above HW (ft)


CHASKA CREEK
DIVERSION
LEVEE IMPROVEMENTS



SYMBOL | DESCRIPTION | DATE | APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

DESIGNED BY
DRAWN BY
CHECKED BY

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
DETAIL BORING LOGS

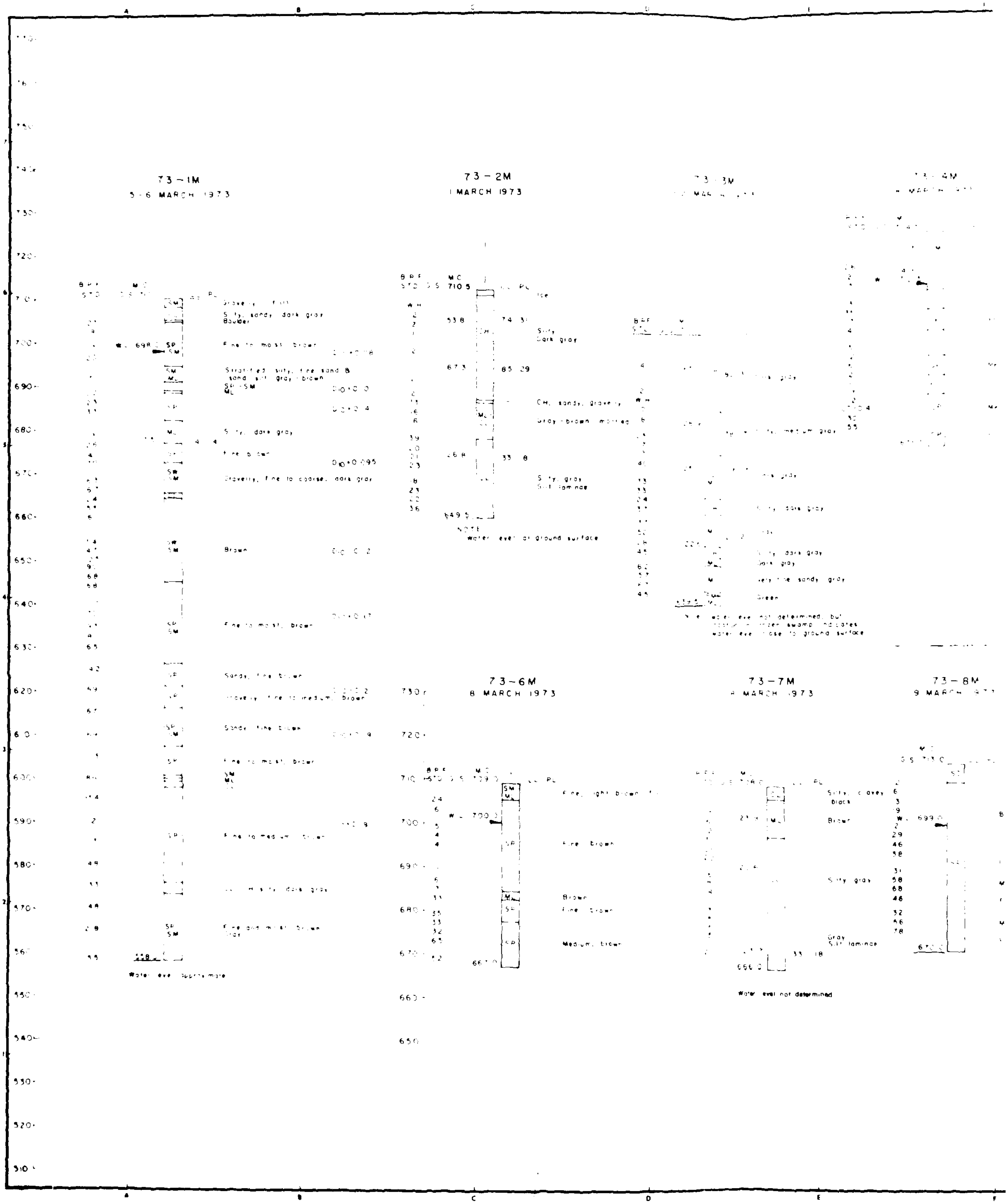
SUBMITTED BY

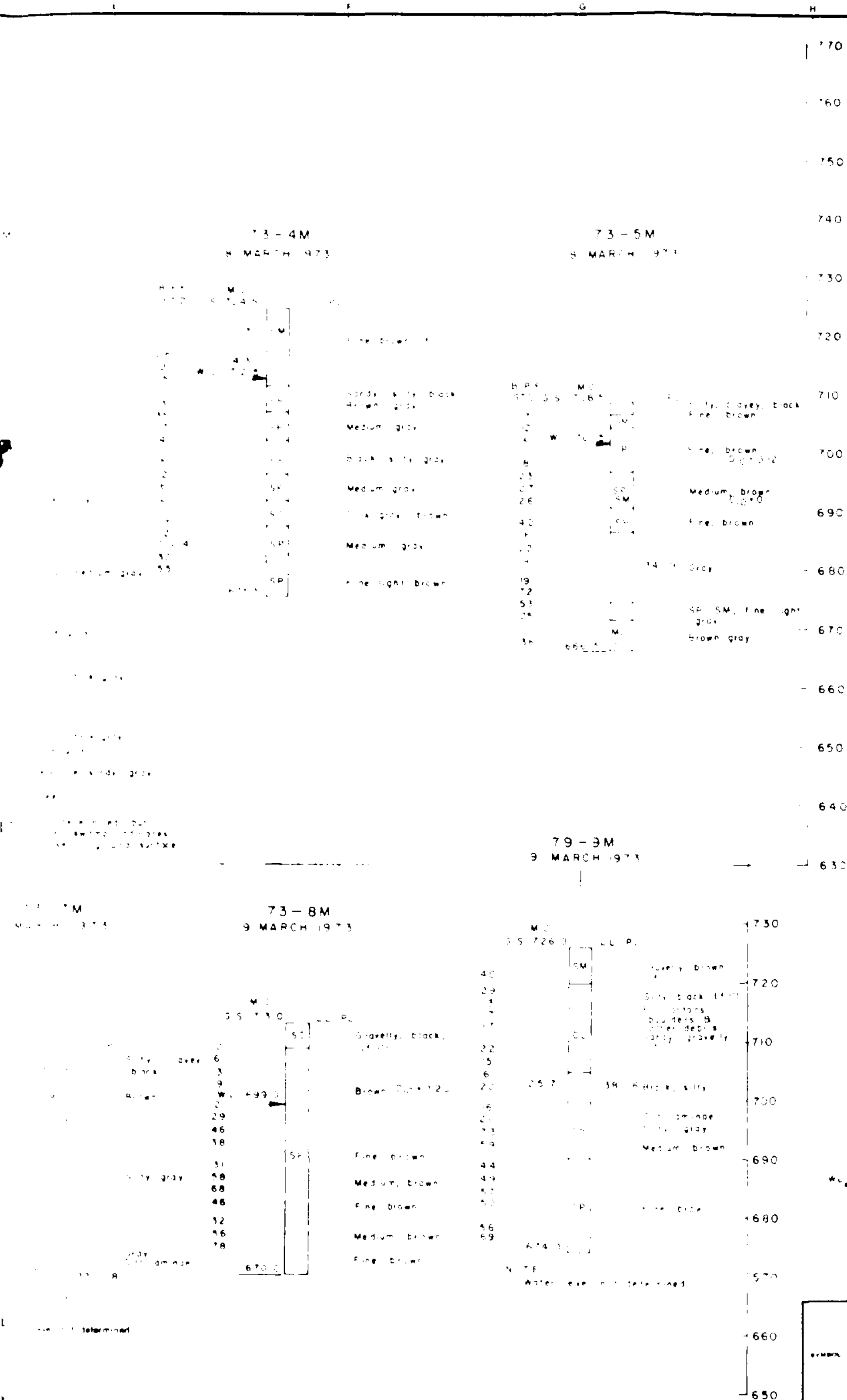
APPROVED

DATE

= 400

DRAWING NUMBER
M34-CH-R-5/14
SHEET 1 OF 6


73-1M
5-6 MARCH 1973
73-2M
1 MARCH 1973
73-3M
73-4M
73-6M
8 MARCH 1973
73-7M
73-8M
Water level not determined
Water level at ground surface
Fine to moist, brown
Gravelly, fine to coarse, dark gray
Silty, dark gray
Brown
Fine, brown
Medium, brown
Silty, gray
Silt laminae



BORING NOTES

1. General: the legend presents only the basic soils; to complete the classification, pertinent information is added to the right of the boring log.
2. Dual classification: where soil is considered to be on the border line of two or more groups a double symbol is used (E.G. (GP-GM) or (CL-CM))
3. Blow count: blow counts are shown to the left of the boring logs and are the number of blows necessary to drive the sampler used a distance of 12 inches. Sampler size and penetration effort are noted on the logs. A unmarked blow counts are for a standard penetration test, using a $1\frac{3}{8}$" x 2" sampler, 140 lb hammer and 30" drop
4. Soil color: is shown as lt (light), dk (dark), br (brown), gr (gray), and (black) to the right of the boring log
5. For boring locations, see plate 5-1
6. Elevation: all elevations shown are in feet (M S L - U.S.G.S 1912 adj.)
7. Moisture content: the natural moisture content in percent of dry weight is shown to the left of the boring log.
8. Atterberg limits: liquid limit (L L) and plastic limit (PL) are shown to the right of the boring log

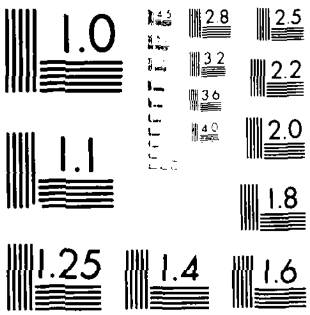
GP	POORLY GRADED GRAVELS, LITTLE OR NO FINES
GC	CLAYEY GRAVELS, GRAVEL SAND CLAY MIXTURES
SW	WELL GRADED SAND, LITTLE OR NO FINES
SP	POORLY GRADED SANDS, LITTLE OR NO FINES
SM	SILTY SANDS
SC	CLAYEY SANDS
ML	INORGANIC SILTS, LIQUID LIMIT LESS THAN 50
CL	INORGANIC CLAYS LOW TO MEDIUM PLASTICITY, LIQUID LIMIT LESS THAN 50
CH	INORGANIC CLAYS, HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
OL	ORGANIC SILTS OR CLAYS, LOW PLASTICITY
WL	WATER LEVEL AT DATE OF BORING

68-1M MACHINE BORING
1 MAY 1979 DATE BORING WAS TAKEN

DESIGNED BY P D M
DRAWN BY M G N
CHECKED BY W G W
SUBMITTED BY
APPROVED
PHASE

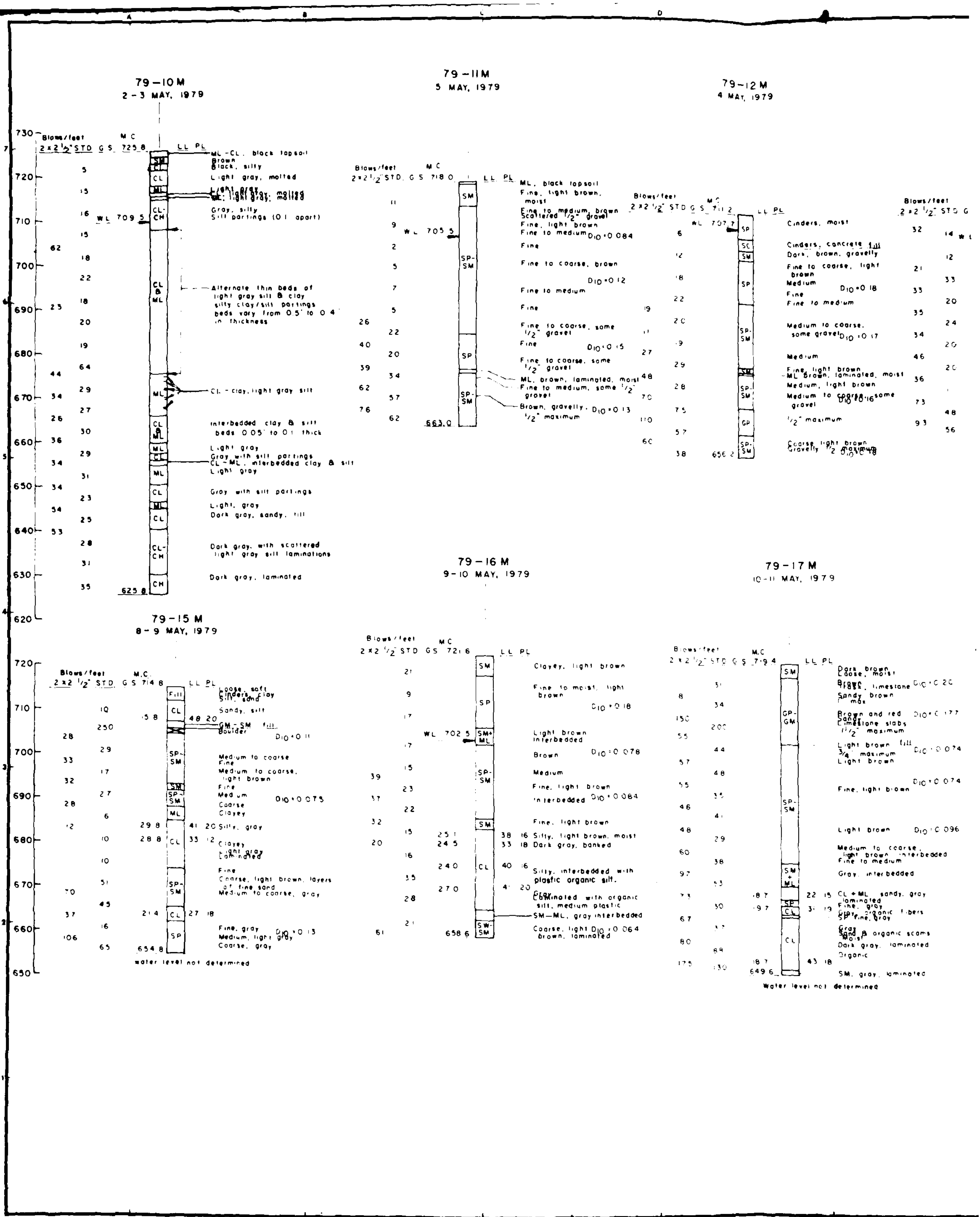
AD-A184 474 MINNESOTA RIVER AT CHASKA MINNESOTA TECHNICAL APENDIXES LIMITED REEVALUA..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT AUG 82 6/9

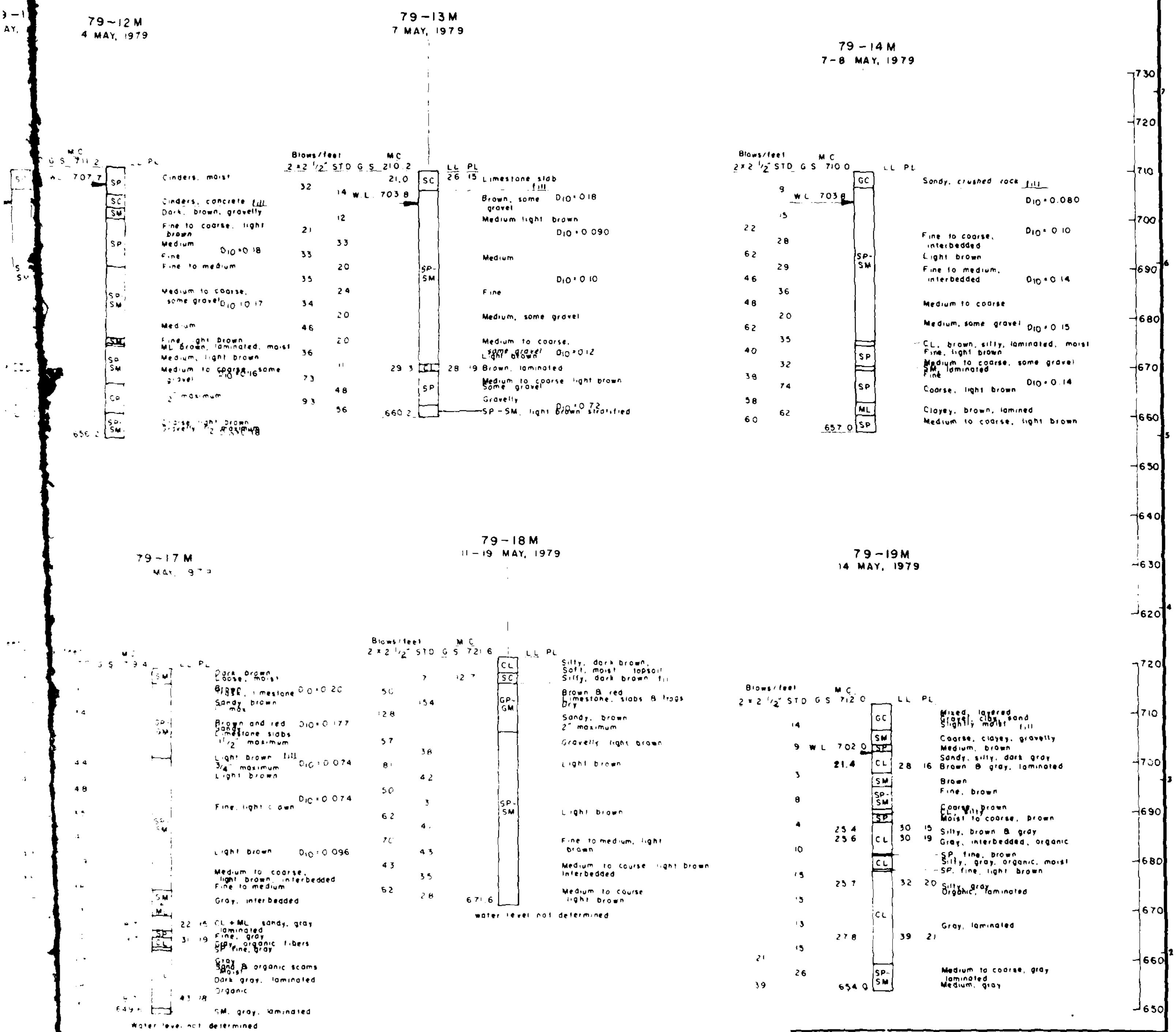
UNCLASSIFIED F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A


79-10M
2-3 MAY, 1979
79-11M
5 MAY, 1979
79-12M
4 MAY, 1979
79-15M
8-9 MAY, 1979
79-16M
9-10 MAY, 1979
79-17M
10-11 MAY, 1979
Blows/feet
2x2 1/2" STD
M.C.
LL PL
ML-CL, black topsoil
Light gray, molted
Gray, silty
Silt partings (0.1' apart)
Alternate thin beds of light gray silt & clay silty clay/silt partings beds vary from 0.5' to 0.4' in thickness
CL - clay, light gray silt
Interbedded clay & silt beds 0.05' to 0.1' thick
Light gray
Gray with silt partings
CL-ML, interbedded clay & silt
Dark gray, sandy, fill
Dark gray, with scattered light gray silt laminations
Dark gray, laminated
ML, black topsoil
Fine, light brown, moist
Fine to coarse, brown
Fine to medium
Fine to coarse, some 1/2" gravel
ML, brown, laminated, moist
Brown, gravelly, 1/2" maximum
Cinders, moist
Cinders, concrete fill
Medium to coarse, some gravel
Clayey, light brown
Light brown interbedded
Silty, light brown, moist
Dark gray, banded
Silty, interbedded with plastic organic silt
SM-ML, gray interbedded
Coarse, light brown, laminated
Gray, interbedded
SM, gray, laminated
water level not determined
Water level not determined



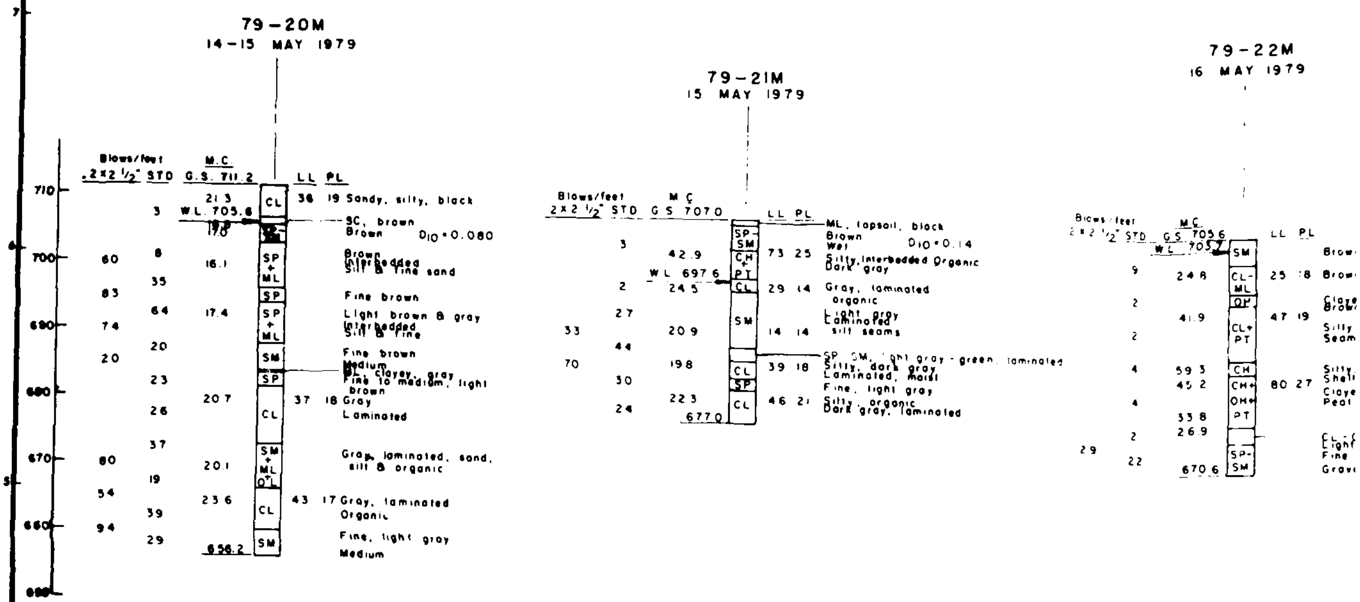
FLOOD CONTROL - MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
BORING LOGS
79-10M THRU. 79-19M

DESIGNED BY P.O.M.
DRAWN BY
CHECKED BY W.O.W.
SUBMITTED BY
APPROVED

DATE 17 OCTOBER 1979

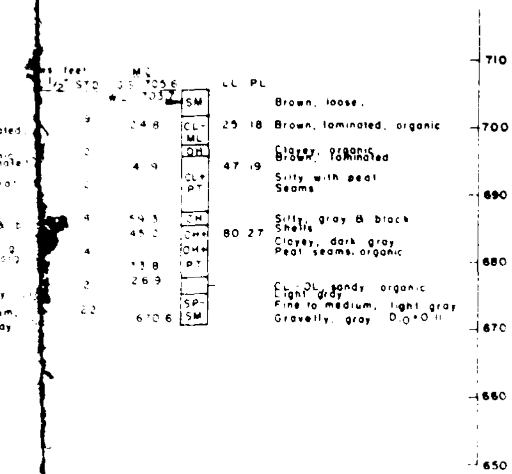
DRAWING NUMBER
M34-CH-R-5/16
SHEET 3 OF 6

PLATE 5-3



79-20M
14-15 MAY 1979
Blows/feet
2x2 1/2" STD
M.C.
G.S. 711.2
LL PL
710
700
690
680
670
660
WL 705.6
Sandy, silty, black
SC, brown
Brown
Interbedded
Silt & fine sand
Fine brown
Light brown & gray
Interbedded
Silt & fine
Fine brown
Medium
Fine to medium, light brown
Gray
Laminated
Gray, laminated, sand, silt & organic
Gray, laminated
Organic
Fine, light gray
Medium
656.2
79-21M
15 MAY 1979
Blows/feet
2x2 1/2" STD
M.C.
G.S. 707.0
LL PL
W.L. 697.6
ML, topsoil, black
Brown
Wet
Silty, interbedded organic
Dark gray
Gray, laminated
Organic
Light gray
Laminated
silt seams
Silty, dark gray
Laminated, moist
Fine, light gray
Silty, organic
Dark gray, laminated
677.0
79-22M
16 MAY 1979
Blows/feet
2x2 1/2" STD
M.C.
G.S. 705.6
W.L. 705.7
LL PL
670.6

79-22M
16 MAY 1979



DESIGNED BY P.D.M.

CHECKED BY W.G.W.

SUBMITTED BY

APPROVED

MINNESOTA RIVER

PHASE GENERAL DESIGN MEMORANDUM

BORING LOGS

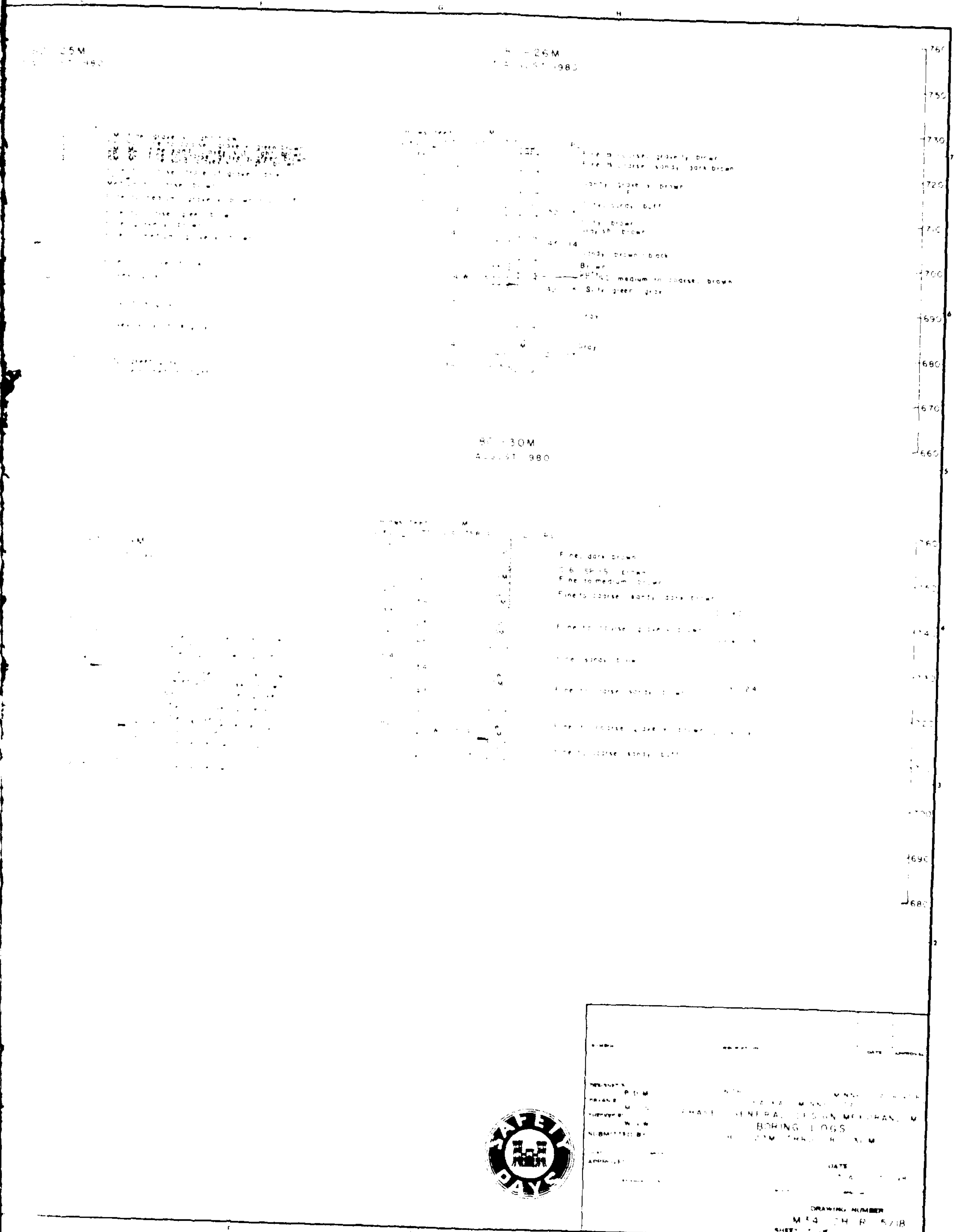
DATE

DRAWING NUMBER

SHEET 4 OF 6

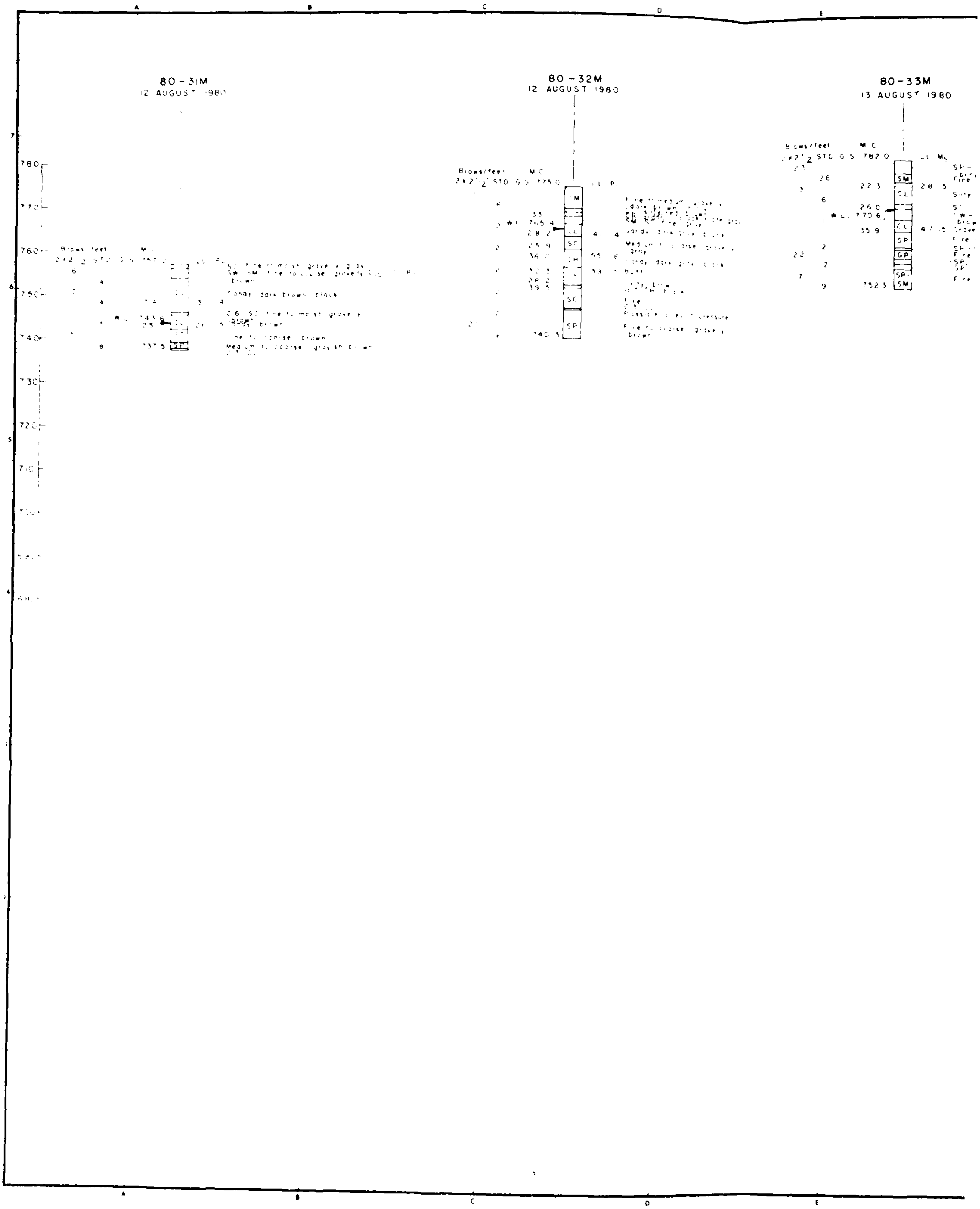
PLATE 5 4

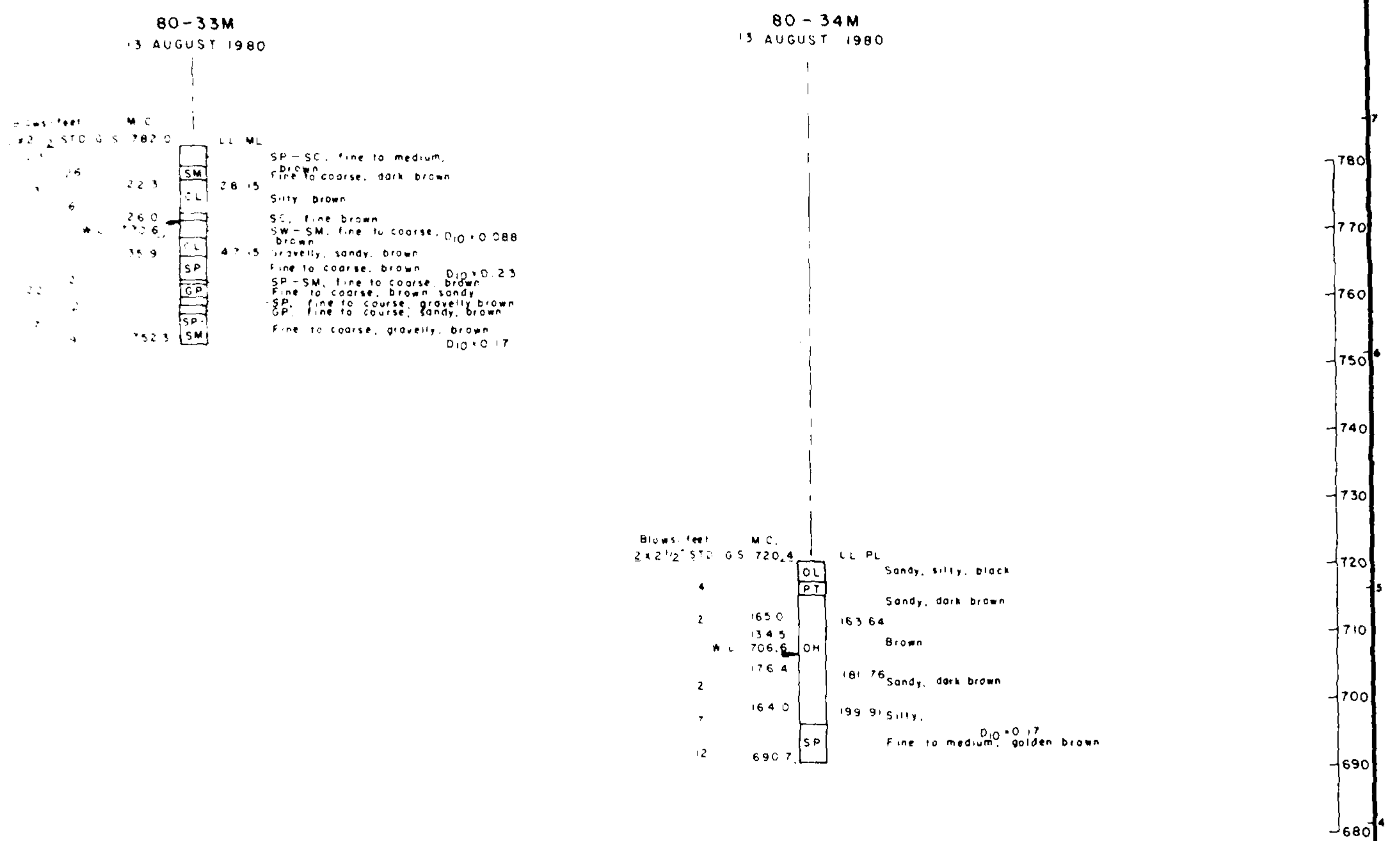
80-23M
5 AUGUST 1980
80-24M
6 AUGUST 1980
80-25M
80-27M
8 AUGUST 1980
80-28M
Blows/feet
M.C.
STD
LL PL
Gravelly, dark brown
Sandy, brown
Fine to coarse, gravelly, dark brown
Fine to coarse, brown
Fine to medium, gravelly, brown, black
Brown
Sandy, silty, black
Dark brown, black, quick concrete
Sandy, dark brown
Fine to medium, reddish brown
Brown
Sandy, gray
Clayey, gray
Fine, gray
Fine to coarse, gravel
Sandy, brown
Fine to coarse, brown
Medium
Water level in auger hole
Gravelly
Coarse sand, gravel
750
740
730
720
710
700
690
680
670
660
760



AUGUST 1980
Fine to coarse, gravelly, brown
Fine to coarse, sandy, dark brown
Sandy, gravelly, brown
Silty, brown
Sandy, brown, black
Brown
Silty, green, gray
Gray
Fine, dark brown
Fine to medium, brown
Fine to coarse, sandy, dark brown
Fine, sandy, brown
Fine to coarse, sandy, buff
750
730
720
710
700
690
680
670
660
690
680
DRAWING NUMBER
BORING LOGS
SUBMITTED BY
APPROVED
DATE

PLATE 5


80-31M
12 AUGUST 1980
80-32M
12 AUGUST 1980
80-33M
13 AUGUST 1980
Blows/feet
M.C.
SM
CL
SC
CH
SP
GP
780
770
760
750
740
730
720
710
700
Fine to coarse, brown
Medium to coarse, grayish brown
Sandy, dark brown, black
Possible clay pressure
Fine to coarse, gravelly brown



SYMBOL	DESCRIPTION	DATE	APPROVAL

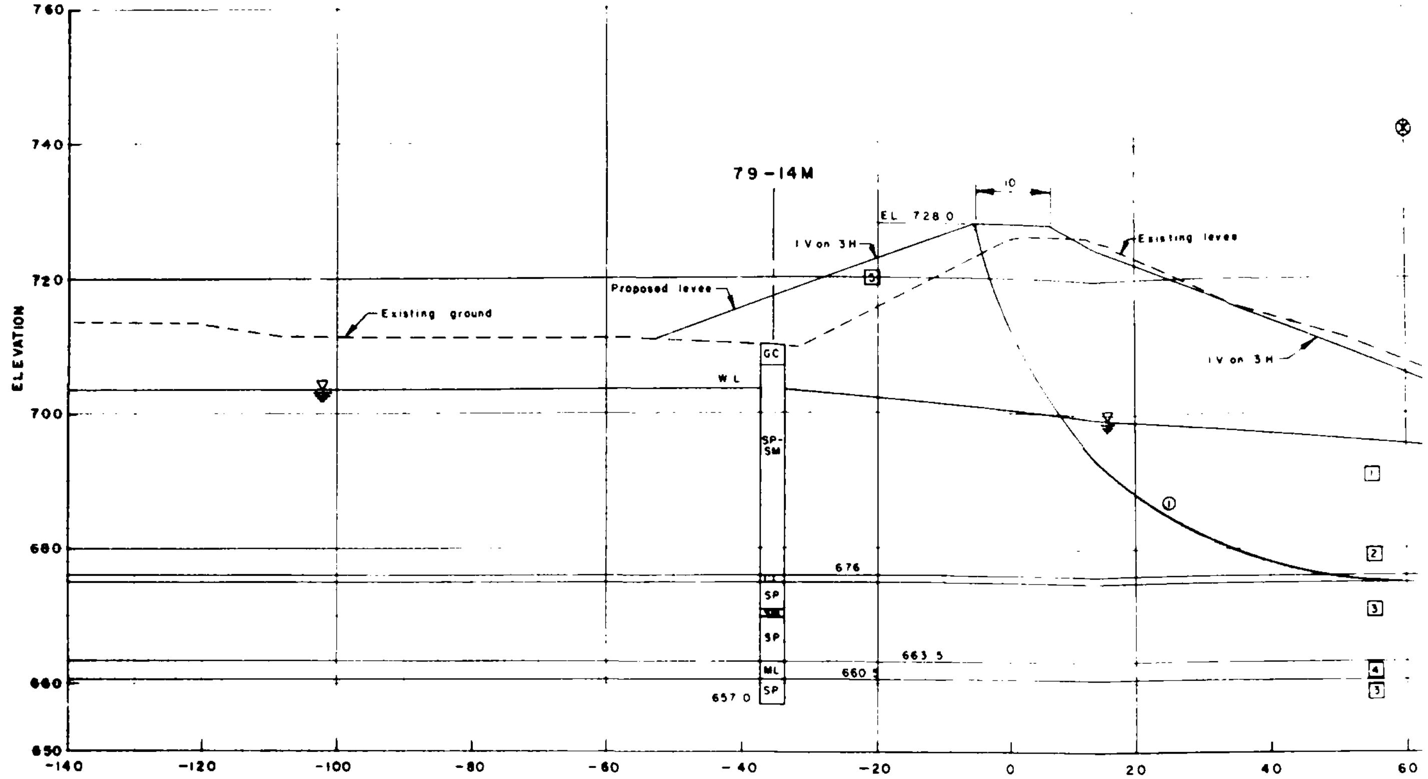
DESIGNED BY P O M
DRAWN BY M G N
CHECKED BY W G W
SUBMITTED BY

APPROVED

FLOOD CONTROL — MINNESOTA RIVER
CHASKA MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
BORING LOGS
80 - 31M THRU 80 - 34M

DATE
25 AUGUST 1980

DRAWING NUMBER
M34 - CH - R - 5/19
SHEET 6 OF 6



CRITICAL FAILURE SURFACE

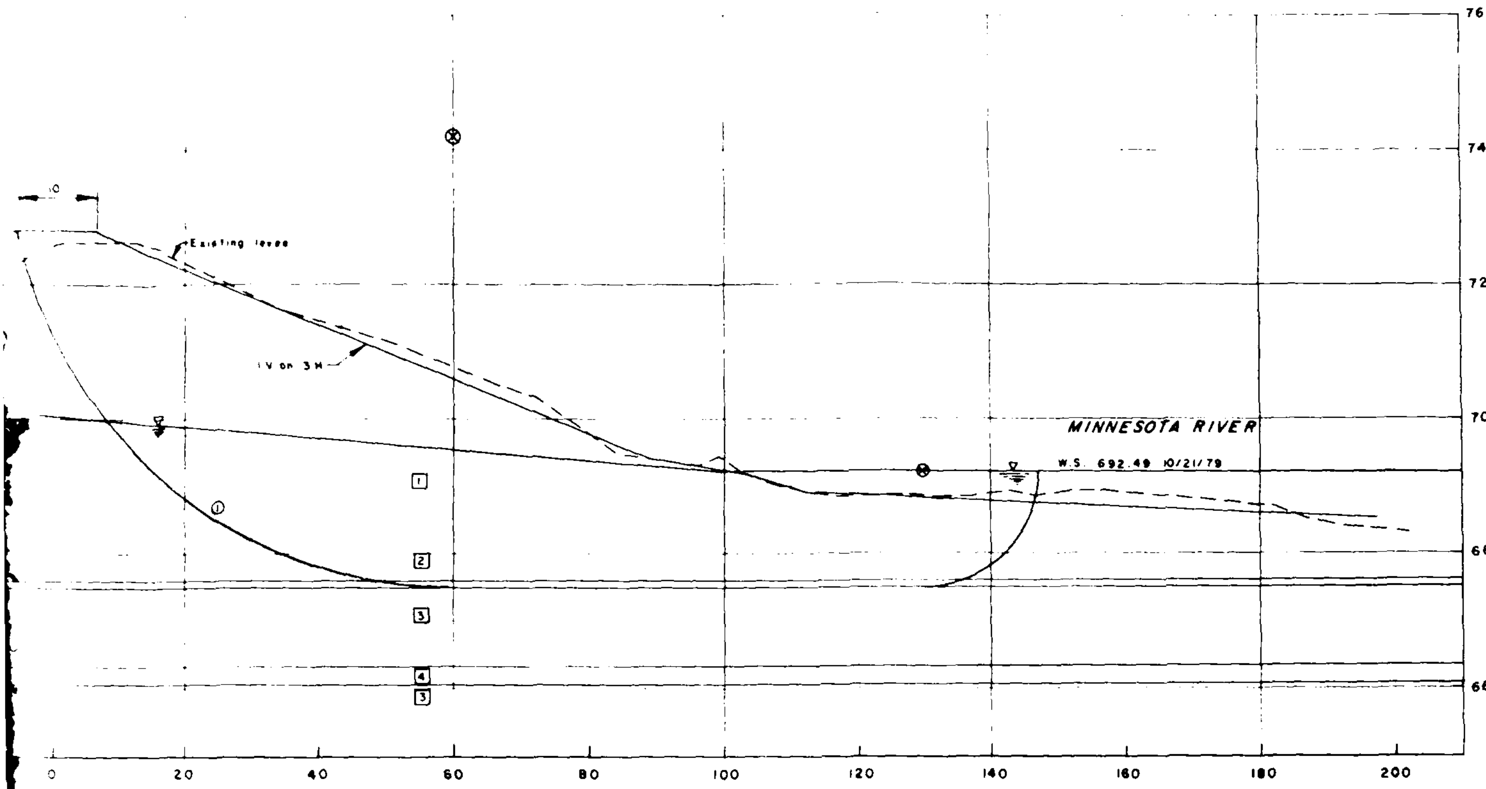
Station 52+00

SCALE IN FEET

Soil constants					
NO.	Mat'l Discription	γ Moist (PCF)	γ Saturated (PCF)	Q strength	
				C (PSF)	φ (DEG)
1	SP-SM	123	128	0	30
2	CL	115	125	1500*	0
3	SP	120	115	0	32
4	ML	115	125	2000*	0
5	CL	115	120	350*	0

* ASSUMED VALUES

Critical failure surface						
NO	Upper circle		Planar surface			
	X-cen	Y-cen	X coor	Y coor.	X coor.	Y coo
1	64.4	764.3	59.3	764.3	119.1	680



RITICAL FAILURE SURFACE
Station 52+00

SCALE IN FEET

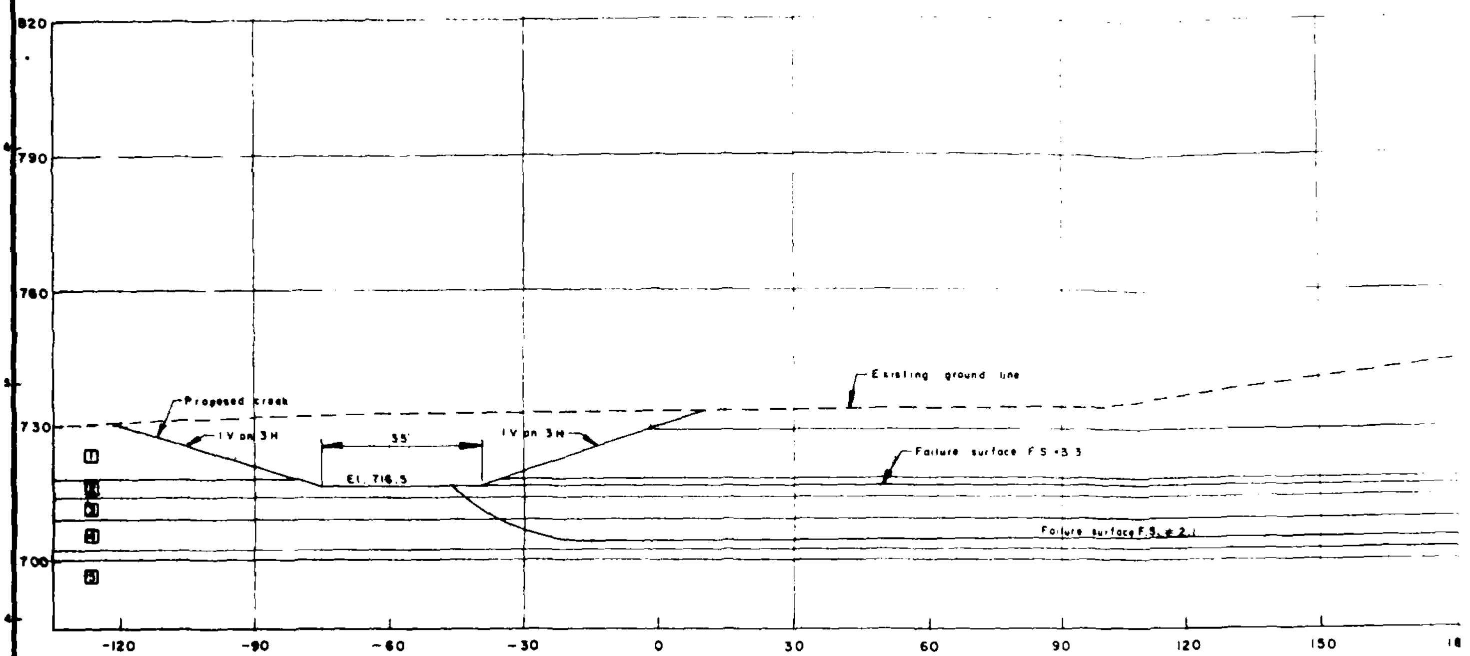
Critical failure surface									
NO	Upper circle		Planar surface				Lower circle		Safe fact
	X-cen	Y-cen	X coor	Y coor.	X coor.	Y coor.	X-cen.	Y-cen	
1	64 4	764 3	59 3	764 3	119 1	680 4	106 9	713 2	1 49

P.D.M.
W.B.W.
SUBMITTED BY:
APPROVED:

FLOOD CONTROL MINNESOTA RIVER
CHASKA, MINNESOTA
PHASE I GENERAL DESIGN MEMORANDUM
MINNESOTA RIVER LEVEE
LEVEE STABILITY ANALYSIS

DATE

DRAWING NUMBER
M34-CH-R-5/20
SHEET 1 OF 3



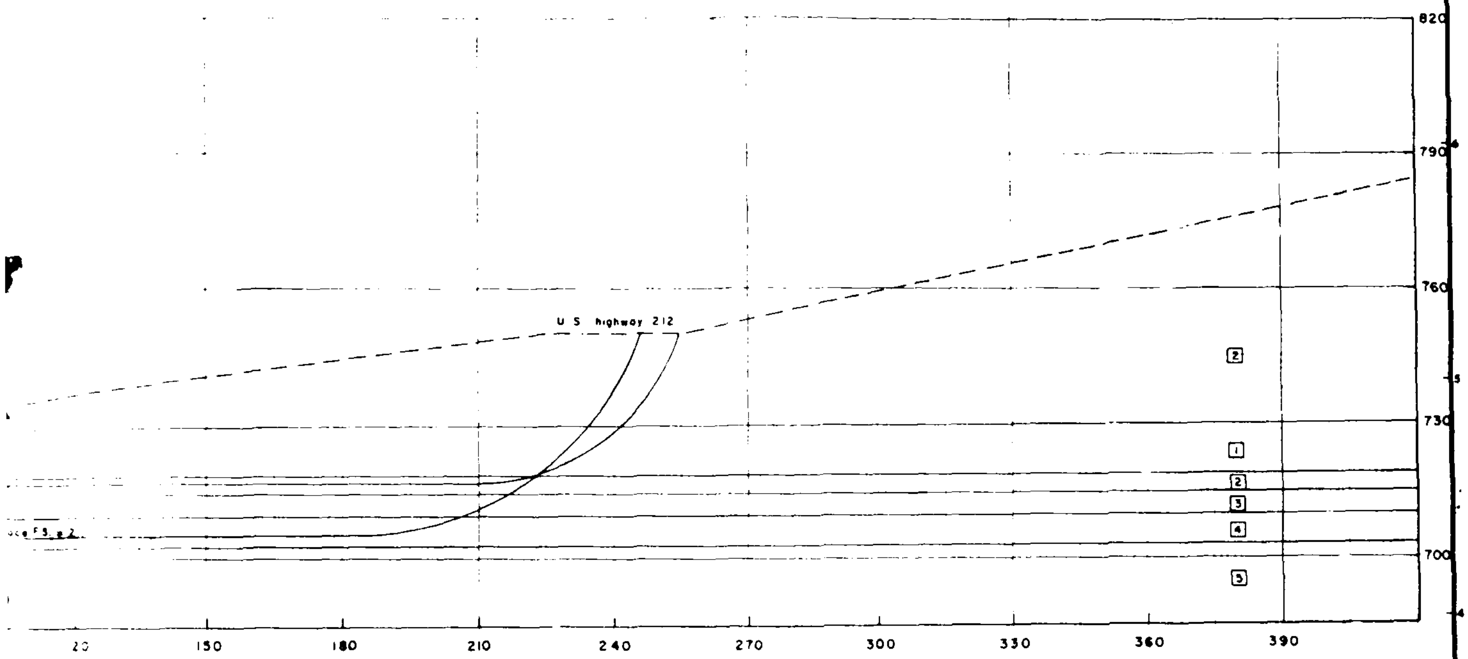
<u>EMBANKMENT SECTION–CRITICAL FAILURE SURFAC</u>

<u>STATION 36+00</u>

SCALE IN FEET

Design constants					
No	Mat'l discription	γ moist (PCF)	γ sat (PCF)	Q–strength	
				C (PSF)	ø (DEG)
1	SP–SM	123	128	0	30
2	CL	115	120	550	0
3	SC	121	125	0	25
4	CH	115	121	500	0
5	SP	120	125	0	30

Fai			
Upper circle		R	
X–cen.	Y–cen	X–coor.	Y–
184.5	763.6	184.5	70
210.0	763.6	210.0	71



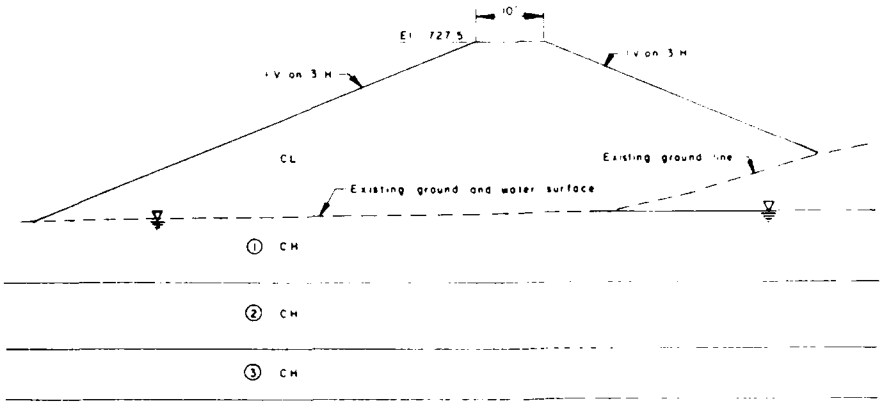
SECTION – CRITICAL FAILURE SURFACE
STATION 36 + 00
SCALE IN FEET

Failure surface parameters								
Upper circle		Planer surface				Lower circle		Safe Fact.
X – cen	Y – cen	X – coor.	Y – coor.	X – coor.	Y – coor.	X – cen	Y – cen	
84.5	763.6	184.5	705.0	–15.0	705.0	–15.0	749.5	2.159
200	763.6	210.0	716.5	–34.5	716.5	–34.5	725.8	3.339

SAFETY PAYS

SYMBOL	DESCRIPTION DATE APPROVAL
DESIGNED BY: P D M	FLOOD CONTROL MINNESOTA RIVER CHASKA, MINNESOTA PHASE I GENERAL DESIGN MEMORANDUM CHASKA CREEK DIVERSION STABILITY ANALYSIS
DRAWN BY: M G N	
CHECKED BY: W.G.W.	
SUBMITTED BY:	
APPROVED:	DATE:
	SCALE 1" = 100'
	DRAWING NUMBER M34 – CH – R – 5/21 SHEET 2 OF 3

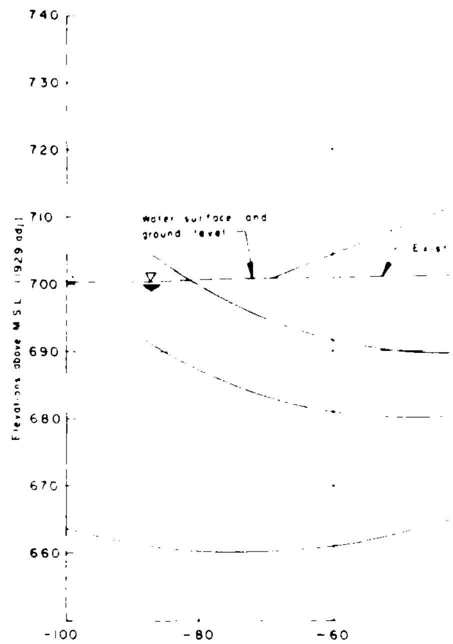
PLATE 5-8



SECTION USED FOR SETTLEMENT ANALYSIS

STATION 7+00

SCALE 1:10



Calulations for settlement of center line (assuming one dimensional consolidation)

Assume levee specific weight = $\gamma = 120\ lb/ft^3$
levee wt = $120\ lb/ft^3 \times 26\ ft = 3{,}120\ lb/ft^2 = 1.56\ T/ft^2$
Moisture content = 65.5%, assume 70%
$\gamma sat = 100\ lb/ft^3$ } Table 1.4 (Peck, Hanson, Thornburn)
e = voids ratio = 1.9
$\gamma sub = \gamma sat - \gamma w = 100\ lb/ft^3 - 62.5\ lb/ft^3 = 37.5\ lb/ft^3$
Liquid limit = L.L. = 85%
$\Delta H = H \frac{Cc}{1+e} \log(1 + \frac{\Delta P}{P_1})$

Cc = 0.007 (liquid limit − 10%) − Skeptons Formula

Cc = 0.007(85 − 10) = 0.525

The single homogeneous layer was divided into 3 sections

$H_1 = 10$ feet $H_2 = 10$ feet $H_3 = 7.5$

$P_{11} = 187.5\ lb/ft^2$ $P_{12} = 562.5\ lb/ft^2$ $P_{13} = 890.6\ lb/ft^2$

$\Delta P_1 = 2080\ lb/ft^2$ $\Delta P_2 = 1560\ lb/ft^2$ $\Delta P_3 = 924\ lb/ft$

$\Delta H_1 = 10\ ft\ \frac{0.525}{(1+1.9)} \log(1 + \frac{2080\ lb/ft^2}{187.5\ lb/ft^2}) = 1.96\ ft$

$\Delta H_2 = 10\ ft\ \frac{0.525}{(1+1.9)} \log(1 + \frac{1560\ lb/ft^2}{562.5}) = 1.04\ ft$

$\Delta H_3 = 7.5\ ft\ \frac{0.525}{(1+1.9)} \log(1 + \frac{924}{890.6}) = 0.42$

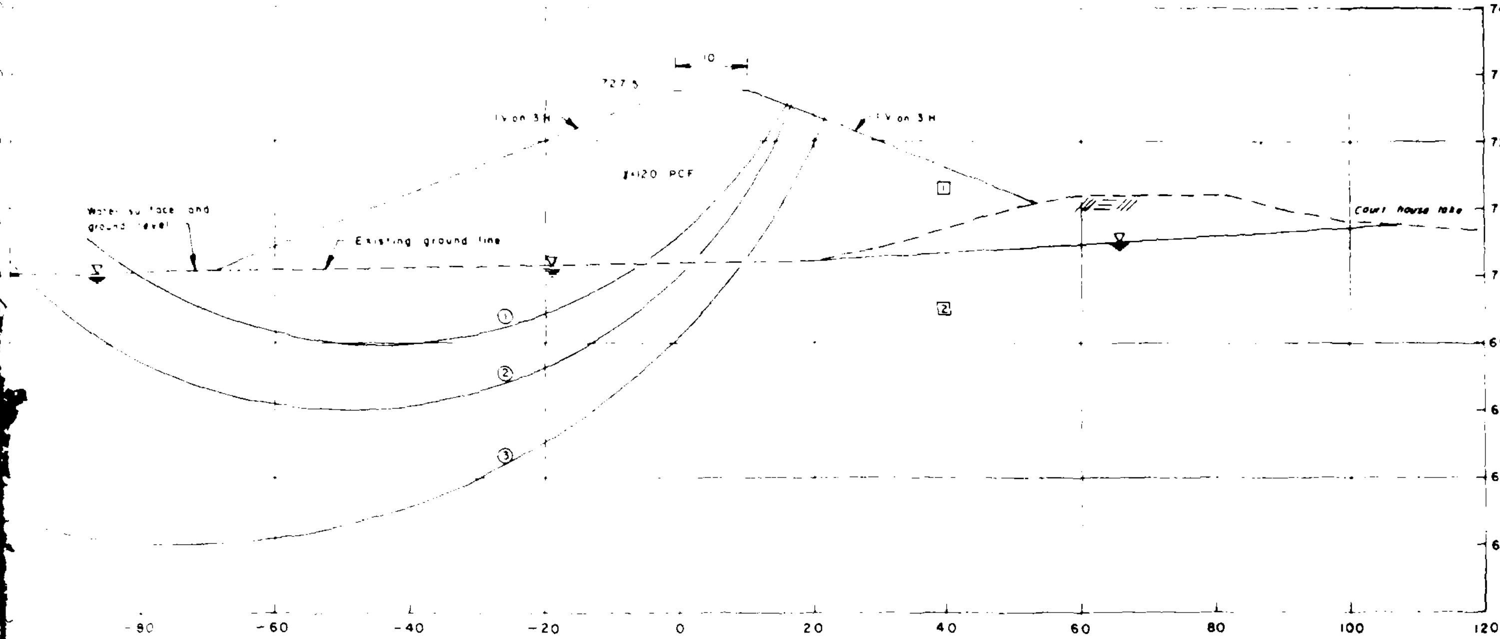
Total settlement H = 3.42 ft

Depth (ft.)	Stress of center line
1	2836 PSF
3	2400 PSF
5	2080 PSF
7	1835 PSF
9	1642 PSF
11	1486 PSF
13	1357 PSF
15	1248 PSF
17	1156 PSF
19	1076 PSF
21	1006 PSF
23	945 PSF
25	891 PSF
27	843 PSF

VERTICAL STRESSES DUE TO LEVEE FILL ONLY

		Design con
No	Mat'l discription	γ moist PCF
1	CL	115
2	CH	98

★ Table 1.4 Pg. 13 Peck, Hanson Th
γmoist = w)γdry = (1+0.7)(58 lb/ft³



SUMMARY OF STABILITY ANALYSIS

STATION 7+00

SCALE IN FEET

No.	Mat. description	Design constants			
		γ moist (PCF)	γ sat. (PCF)	Q-strength	
				C (PSF)	Ø (DEG)
1	CL	115	120	550	0
2	CH	98	100★	550	0

★ Table 4 Pg 13 Peck, Hanson, Thornburn 2nd edition

γmoist = w(γdry) + ... 58 lb/ft³ = 98 lb/ft³

Trial arcs				
Circle no	Tangent elevation	Center		Safety factor
		X	Y	
1	690	-44 1	758 8	1 35
2	680	-48 8	750 1	1 30
3	660	-73.6	763 7	1 38

SYMBOL	DESCRIPTION	DATE	APPROVAL

DESIGNED BY P. D. M.

DRAWN BY

CHECKED BY W. G. W.

SUBMITTED BY

APPROVED

FLOOD CONTROL MINNESOTA RIVER

CHASKA, MINNESOTA

PHASE I GENERAL DESIGN MEMORANDUM

COURT HOUSE LAKE LEVEE

SETTLEMENT AND STABILITY ANALYSIS

DATE

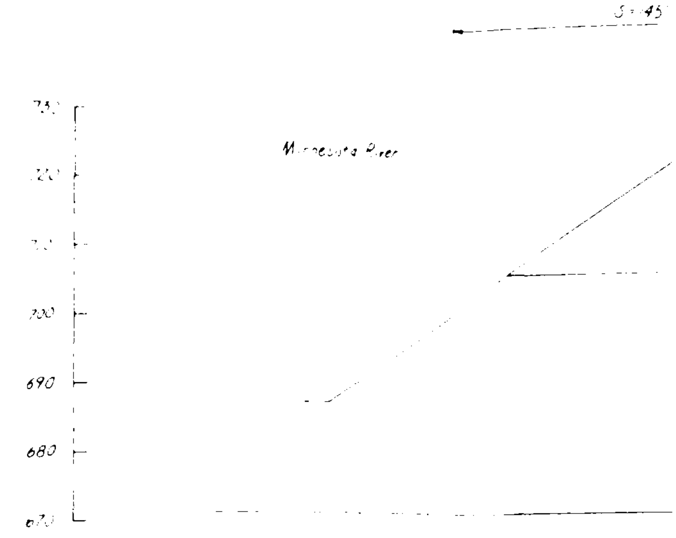
SCALE AS SHOWN

DRAWING NUMBER

M34-CH-R-5/22

SHEET 3 OF 3

PLATE B-9



Seep Berm Design Sample Calculations

$K_f = \frac{\Sigma K_h d}{\Sigma d}$

Use Boring [illegible] As Typical For Pervious Zone

Soil Class	D_{10}	K_h (FPM)	d (Ft)	$K_h d$
SP-SM	0.2	[illegible]	[illegible]	120
	0.1	0.045	[illegible]	[illegible]
			[illegible]	2.49

$K_f = \frac{2.49}{34.6} = 0.072$ FPM

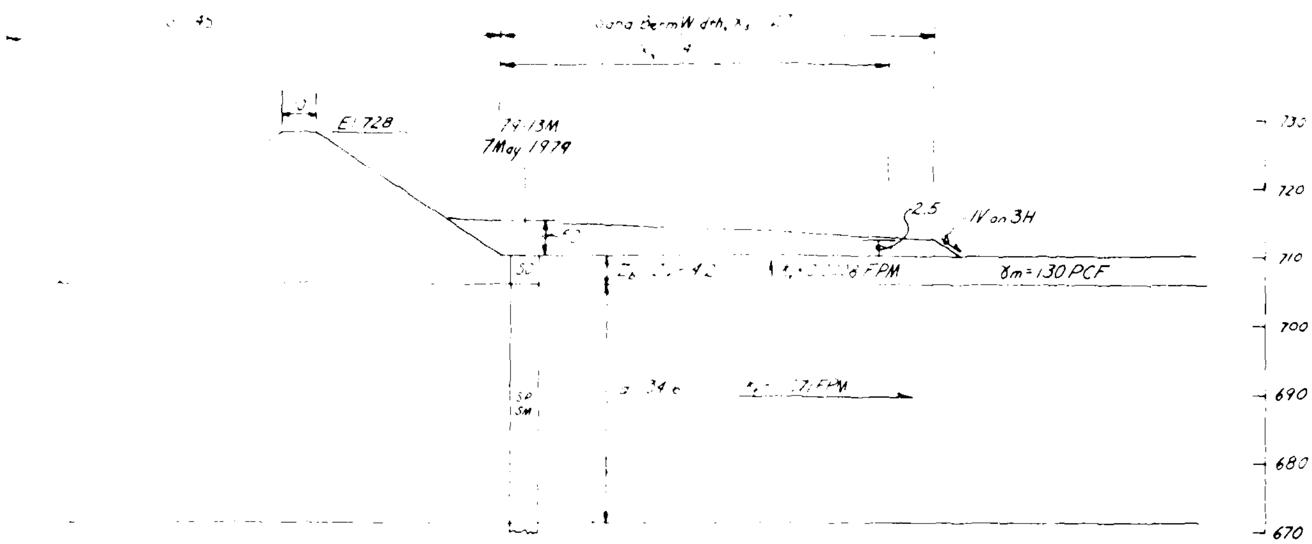
Landside Top Stratum Evaluation

Soil Classification - SC [illegible]

$Z_t = Z_b = 4.2'$

From Table 38, TM 3-424

$K_b = K_v$ (min) = [illegible]8 FPM



Typical Section
(Station 3e+25
Scale. Horiz 1" = 20
Vert 1" = 10'

Case 6 EM 1110-2-1913, p 5-7

$c = \sqrt{\frac{K_f}{K_f d Z_b}} = \sqrt{\frac{0.008}{0.072 \times 34.6 \times 4.2}} = 0.00874$

$X_3 = \frac{1}{c} = \frac{1}{0.00874} = 114$

$L_2 = 130'$

$H = 728 - 710.2 = 17.8'$

$h_o = \frac{H\ X_3}{43d + L_2 + X_3} = \frac{17.8 \times 114}{43 \times 34.6 + \ldots} = 7.84$

$\gamma_t' = \gamma_m - \gamma_w = 125 - 62.5 = 62.5$ PCF (Top Stratum)

$\gamma_f' = \gamma_s - \gamma_w = 120 - 62.5 = 57.5$ PCF (Berm)

Allowable Vertical Gradients

$i_o = 0.3$ - Toe of Levee

$i_1 = 0.8$ - End of Berm

Gradient Without Berm - No Tailwater

$i_o = \frac{h_o}{Z_b} = \frac{7.84}{4.2} = 1.87$ Too High

Semipervious Berm

$X_{sp} = \frac{-A + \sqrt{A^2 - 24(2+r)(1 + S_c - H/h_a)}}{2c(2+r)}$

$r = \frac{i_o}{i_1} = \frac{.3}{.8} = 0.375$

$A = 6 + 3S_c(r+1)$

$S = 0.43d + L_2 = 15 + 130 = 145$

$A = 6 + 3 \times 145 \times 0.00874(.375+1) = 11.2$

$h_a = i_1 Z_t = .8 \times 4.2 = 3.36$ FT.

$X_{sp} = \frac{-11.2 + \sqrt{(11.2)^2 - 24(2+.375)(1 + .00874 \times 145 - 17.8/3.36)}}{2 \times .00874(2+.375)}$

$X_{sp} = 146$ FT

Pervious Berm

$h_o' = h_o = 7.84$ FT.

$X_p = X_3 \ln \frac{h_o'}{h_a} = 114 \ln \frac{7.84}{3.36} = 97$ FT.

Sand Berm

$X_s = \frac{1}{3}(X_p + 2X_{sp}) = \frac{1}{3}(97 + 2 \times 146) = 130$ FT.

$h_o' = h_a\left[1 + cX_s + \left(\frac{2+r}{6}\right)(cX_s)^2\right]$

$h_o' = 3.36\left[1 + 0.00874 \times 130 + \left(\frac{2+.375}{6}\right)(.00874 \times 130)^2\right]$

$h_o' = 8.89$ FT.

$t = \frac{h_o' - \frac{Z_t \gamma_t'}{F\gamma_w}}{1 + \frac{\gamma_f'}{F\gamma_w}} = \frac{8.89 - \frac{4.2 \times 62.5}{1.6 \times 62.5}}{1 + \frac{57.5}{1.6 \times 62.5}} = 3.98$ FT

Use Minimum Crown Thickness of 2.0 FT.

Increase Thickness 25%

Levee Toe $3.98 \times 1.25 = 4.98$ FT. Use. 5.0 FT.

Crown $2.0 \times 1.25 = 2.5$ FT. Use: 2.5 FT

Slope of Berm = $\frac{5.0 - 2.5}{130} = \frac{1}{52}$ OK

SAFETY PAYS

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

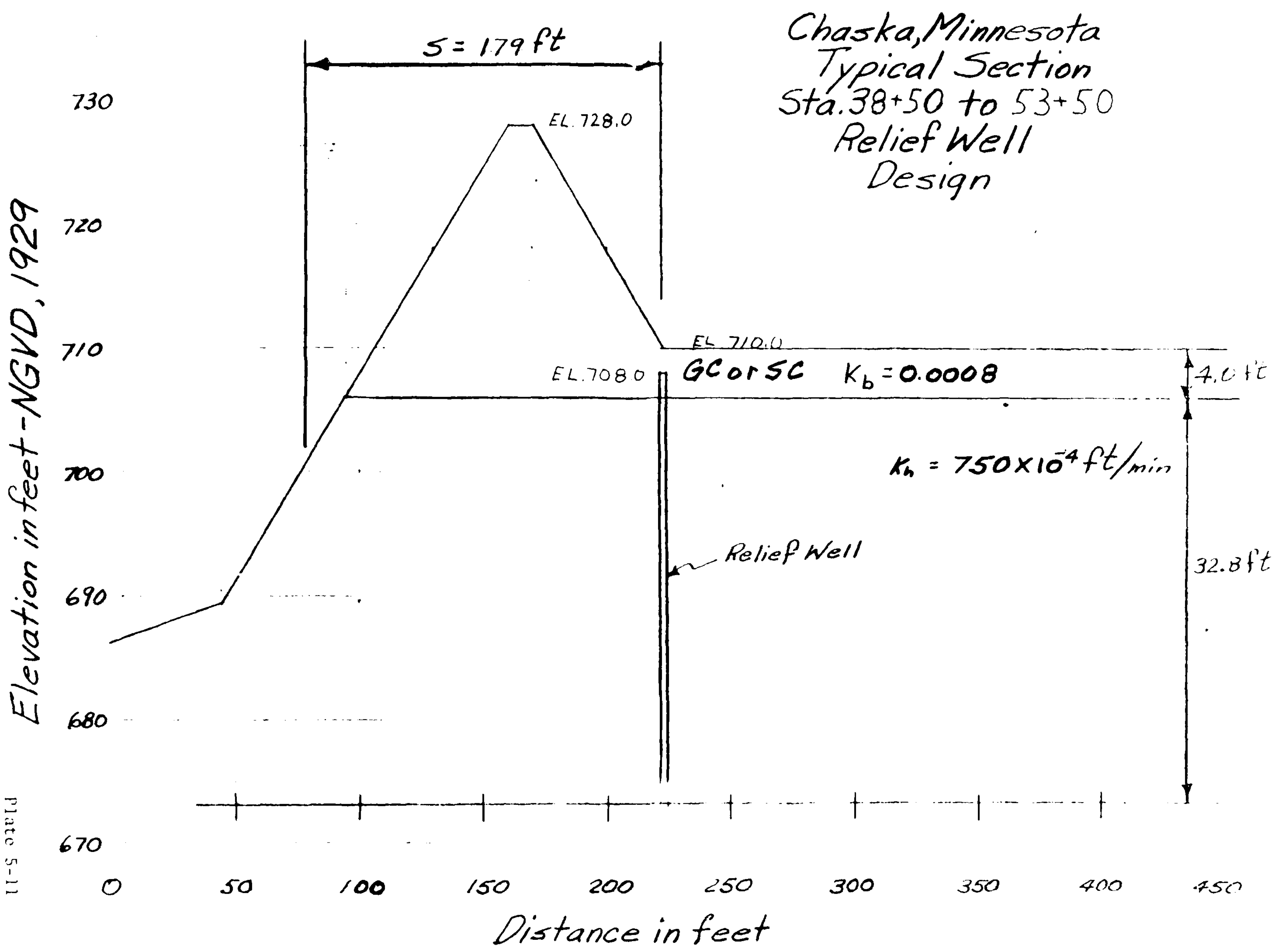
DESIGNED BY: W G W
DRAWN BY: O S M
CHECKED BY:
SUBMITTED BY

PHASE I GENERAL DESIGN MEMORADUM
FLOOD CONTROL
MINNESOTA RIVER AT CHASKA, MINNESOTA
BERM DESIGN

APPROVED: DATE

DRAWING NUMBER
M34-CH-R-5/23
SHEET 1 OF 1

PLATE 7-12


Chaska, Minnesota
Typical Section
Sta. 38+50 to 53+50
Relief Well
Design
S = 179 ft
EL. 728.0
EL. 710.0
EL. 708.0
GC or SC
$K_b = 0.0008$
$K_h = 750 \times 10^{-4}$ ft/min
4.0 ft
32.8 ft
Relief Well
730
720
710
700
690
680
670
Elevation in feet-NGVD, 1929
0
50
100
150
200
250
300
350
400
450
Distance in feet

Seepage Computations — 100 yr. flood

Station 38+50 to 53+50

1. Assume flood profile 3.0 feet below top of levee.
   728.0 - 3.0 = 725.0

2. Total seepage passing levee
   Q_s = 1.74 gpm/ft. of levee

3. Well discharge per foot of levee
   Q_{UEW} = 1.56 gpm/ft.

4. Well spacing = 67.5 feet

5. Flow per well = 1.56 x 67.5 = 105 gpm = 0.23 cfs

6. No. of wells = 24

7. Total well flow = 105 x 24
   = 2520 gpm
   = 5.61 c.f.s.

8. Flow passing wells = 1.74 - 1.56 = 0.18 gpm/ft

9. Total flow passing wells = 0.18 x 1500 = 270 gpm
   = 0.60 cfs

Seepage Computations continued:

10. Permeability of semipervious layer varied
$D = 32.8$ feet $k_f = 0.073$, $Z_{bl} = 4.0$ feet

Depth (D) was determined by taking an average between two different sections.

$$\text{Ave. } D = \frac{30.9 + 34.7}{2} = 32.8 \text{ feet}$$

Average permeability (k_f) from the same sections

$$\text{Ave. } k_f = \frac{0.075 + 0.071}{2} = 0.073 \text{ f.p.m.}$$

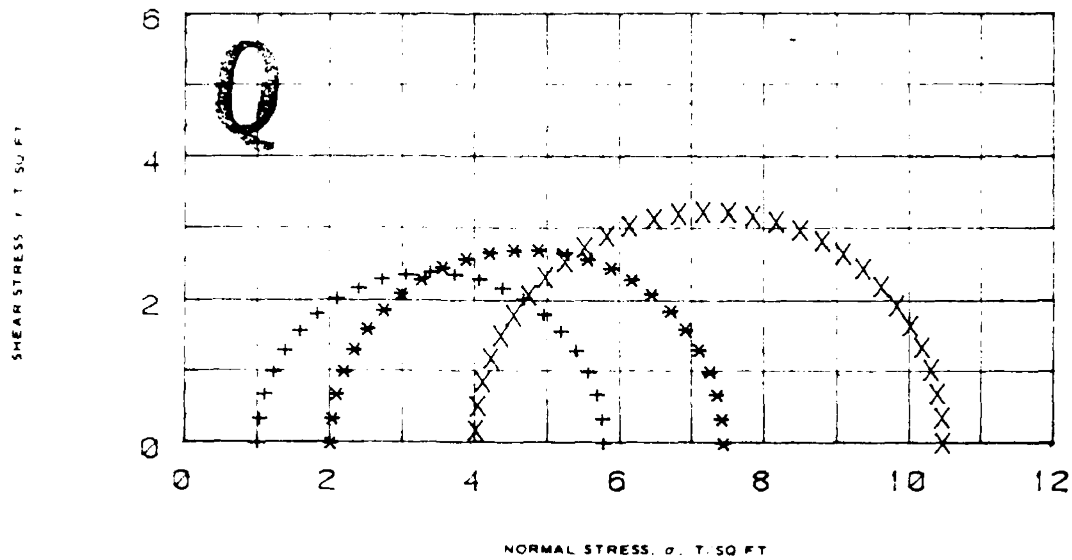
Moist unit weight of landside blanket

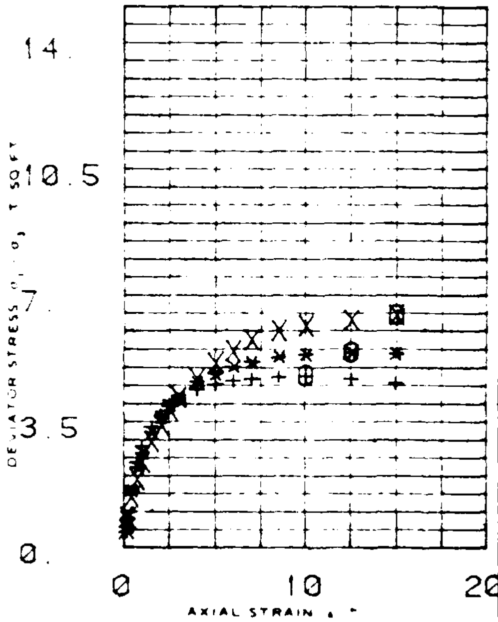
$Z_t = Z_b = 4.0$ feet

11. Soil Type, SC, GC (loose), SM

$\gamma_{moist} = 125 \text{ lb/ft}^3$
$\gamma_{moist} = 120 \text{ lb/ft}^3$
From Mankato D.M. 4 Stage 3A Table B-1

Plate 5-14





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	18.9	18.5	18.7	
	DRY DENSITY LB/CU FT	γ_{d_o}	101.5	99.3	97.9	
	SATURATION, %	S_o	77.	71.	70.	
	VOID RATIO	e_o	.66	.7	.72	
BEFORE SHEAR	WATER CONTENT, %	w_c	18.2	18.4	18.2	
	DRY DENSITY LB/CU FT	γ_{d_c}	102.1	100.7	101.0	
	SATURATION, %	S_c	76.	74.	75.	
	VOID RATIO	e_c	.65	.67	.66	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	4.70	5.43	6.46	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	21	25	31	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	4.58	5.41	6.46	
INITIAL DIAMETER, IN		D_o	1.4	1.4	1.4	
INITIAL HEIGHT, IN		H_o	2.98	3.	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS

LL 45 PL 14 PI 31 Gs 2.7

TYPE OF SPECIMEN UNDISTURBED TYPE OF TEST Q

REMARKS Dark gray, brittle, medium consistency, medium strength at PL, no shine, fast shake reaction. Assumed a specific gravity of 2.70.

PROJECT CHASKA FLOOD CONTROL NCS-IA-80-110-ED-HF

BORING NO. 80-26M SAMPLE NO. 2

DEPTH/ELEV 20.0-21.8

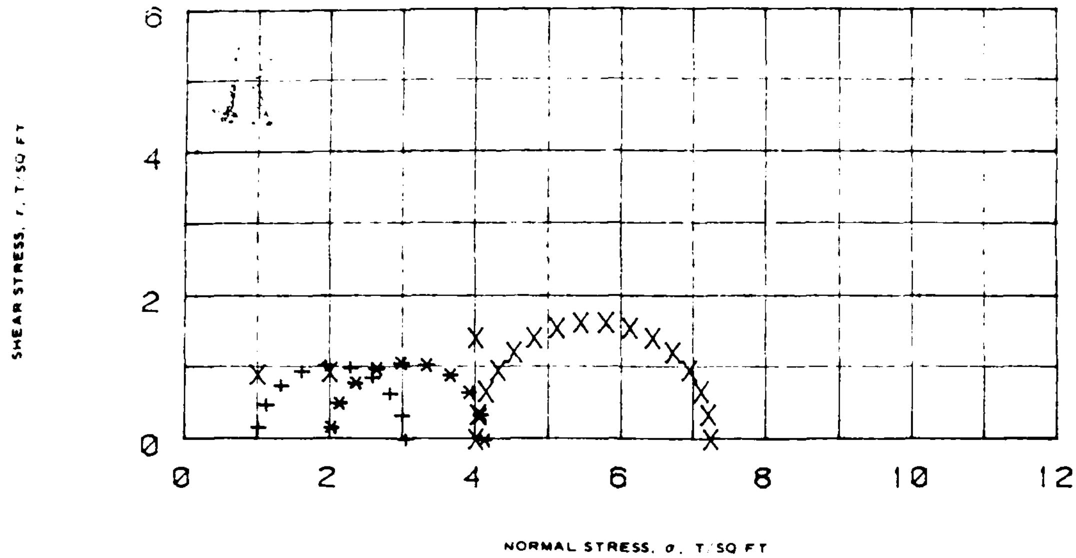
LABORATORY 80/227 DATE 30 DEC 1980

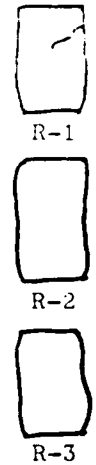
TRIAXIAL COMPRESSION TEST REPORT

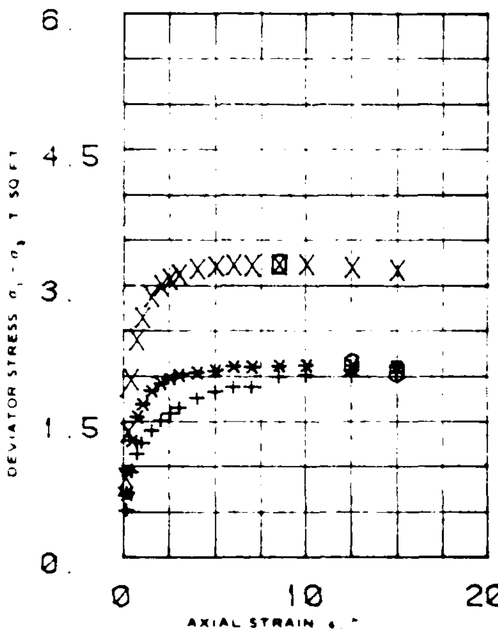
ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 4

Plate 5-15







SPECIMEN NO			1	2	3
INITIAL	WATER CONTENT, %	w_o	19.1	18.	17.4
	DRY DENSITY LB/CU FT	γ_{d_o}	105.4	101.2	101.5
	SATURATION, %	S_o	77.	73.	71.
	VOID RATIO	e_o	.65	.67	.66
BEFORE SHEAR	WATER CONTENT, %	w_c	25.6	25.2	23.9
	DRY DENSITY LB/CU FT	γ_{d_c}	104.9	105.7	106.9
	SATURATION, %	S_c	100.	100.	100.
	VOID RATIO	e_c	.61	.63	.58
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.5	5.5	5.5
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	2.05	2.13	3.24
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	125	102	72
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	2.05	2.11	3.17
INITIAL DIAMETER, IN		D_o	1.4	1.4	1.39
INITIAL HEIGHT, IN		H_o	2.92	2.90	2.90

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS

LL 45	PL 14	PI 31	Gs 2.7

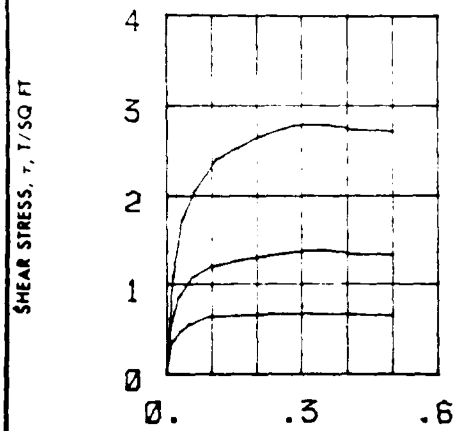
TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	R
PROJECT	CHASKA FLOOD CONTROL NCS-IA-80-110-ED-HF		
BORING NO	80-26M	SAMPLE NO	2
DEPTH/ELEV	20-21.0		
LABORATORY	80/227	DATE	30 DEC 1980

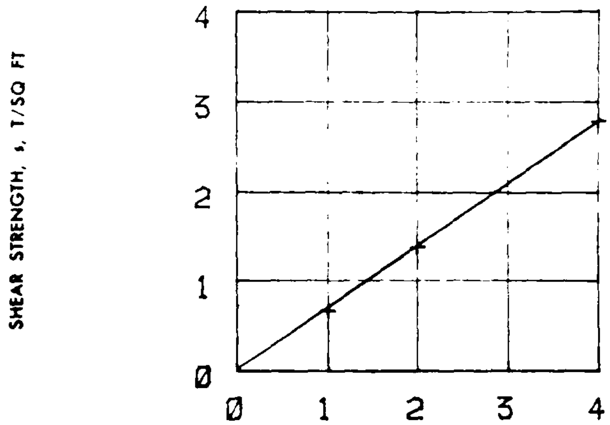
REMARKS R-2 was trimmed from a different core section than R-1 and R-3.

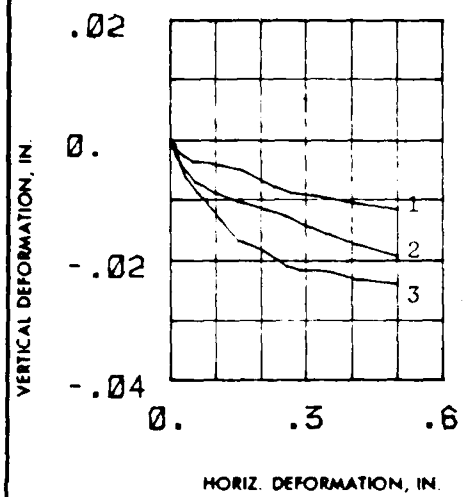
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 5







TEST NO.			1	2	3	
INITIAL	WATER CONTENT	w_o	14.5 %	14.5 %	15.7 %	%
	VOID RATIO	e_o	.85	.81	.76	
	SATURATION	S_o	46. %	48. %	56. %	%
	DRY DENSITY, LB/CU FT	γ_d	91.1	92.9	96.	
VOID RATIO AFTER CONSOLIDATION		e_c	.82	.81	.65	
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	29.2%	27.8 %	22.2 %	%
	VOID RATIO	e_f	.79	.75	.57	
	SATURATION	S_f	100 %	100 %	100. %	%
NORMAL STRESS, T/SQ FT		σ	1.	2.	4.	
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.68	1.39	2.79	
ACTUAL TIME TO FAILURE, MIN		t_f	630	990	690	
RATE OF STRAIN, IN / MIN		y .0001	3.63	3.46	4.09	
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.65	1.33	2.71	

SHEAR STRENGTH PARAMETERS

ϕ' = 34.9°

TAN ϕ = 0.698

c' = ______ T/SQ FT

S

[ ] CONTROLLED STRESS

[X] CONTROLLED STRAIN

TYPE OF SPECIMEN UNDISTURBED 3. IN. SQUARE .506 IN. THICK

CLASSIFICATION

LL 45 | PL 14 | PI 31 | G_s 2.7

REMARKS

PROJECT CHASKA FLOOD CONTROL NCS-IA-80-118-ED-HF

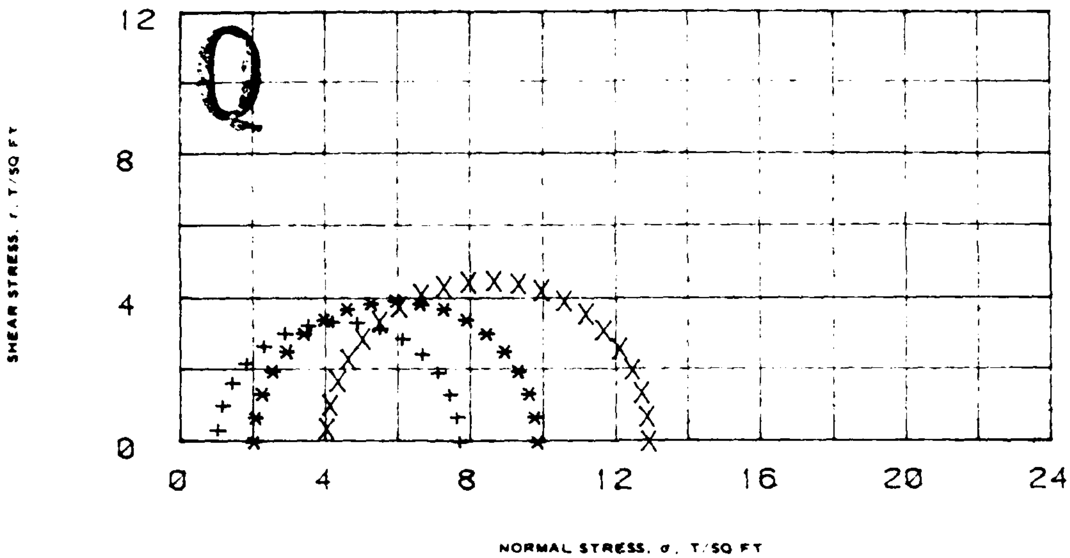
AREA NRD LAB NO: 80/227

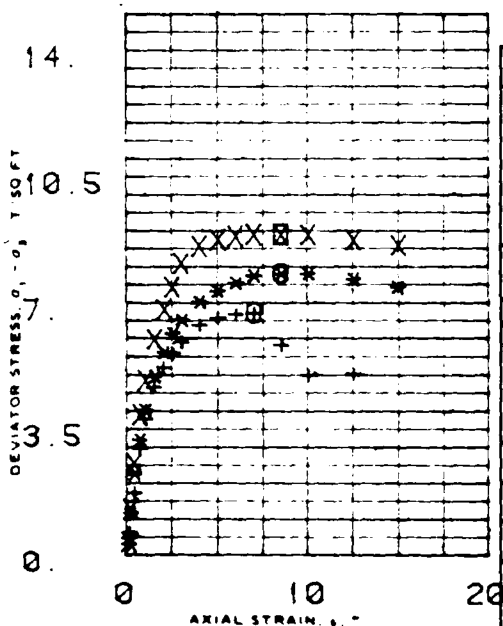
BORING NO. 80-26M SAMPLE NO. 2

DEPTH EL 20.0-21.8 DATE 30 DEC 1980

DIRECT SHEAR TEST REPORT Plate 5-17

ENG FORM





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	19.2	18.2	19.1
	DRY DENSITY, LB/CU FT	γ_{d_o}	107.1	108.1	106.2
	SATURATION, %	S_o	90.	89.	88.
	VOID RATIO	e_o	.57	.56	.59
BEFORE SHEAR	WATER CONTENT, %	w_c	19.2	18.3	18.6
	DRY DENSITY, LB/CU FT	γ_{d_c}	107.5	108.8	107.3
	SATURATION, %	S_c	91.	90.	88.
	VOID RATIO	e_c	.57	.56	.57
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	6.71	7.83	8.9
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	17	20	21
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	5.	7.46	8.59
INITIAL DIAMETER, IN.		D_o	1.4	1.39	1.39
INITIAL HEIGHT, IN.		H_o	2.97	3.	2.98

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS

LL 42	PL 15	PI 27	Gs 2.7	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Gray, brittle, medium consistency, high strength at PL, dull shine, slow shake reaction.
Assumed a specific gravity of 2.70.

PROJECT CHASKA FLOOD CONTROL NCS-IA-80-110-ED-H

BORING NO. 80-2SM SAMPLE NO. 5

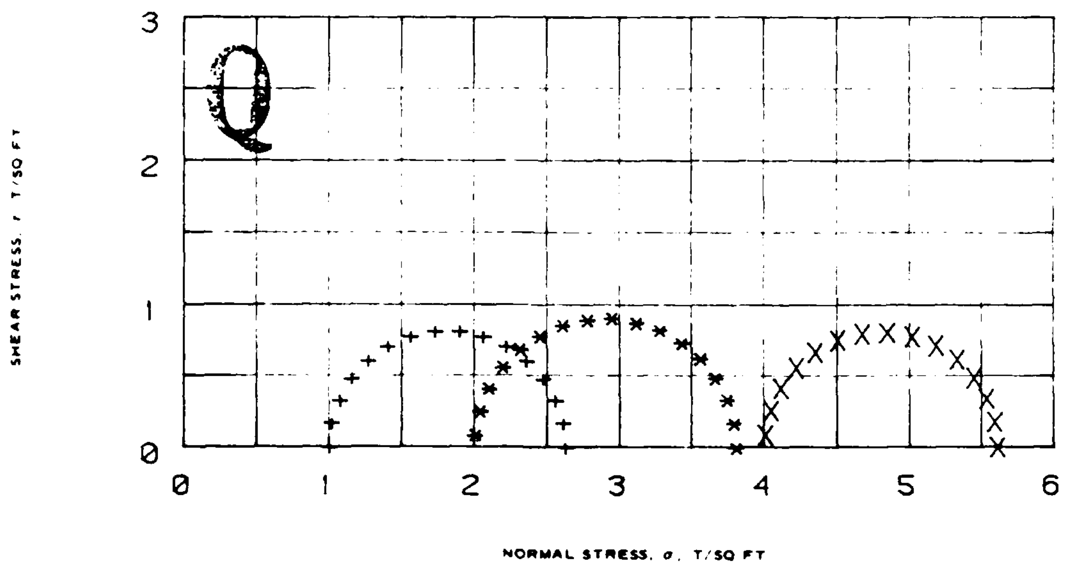
DEPTH ELEV 50.0-51.9

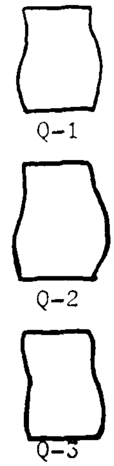
LABORATORY 80/227 DATE 30 DEC 1980

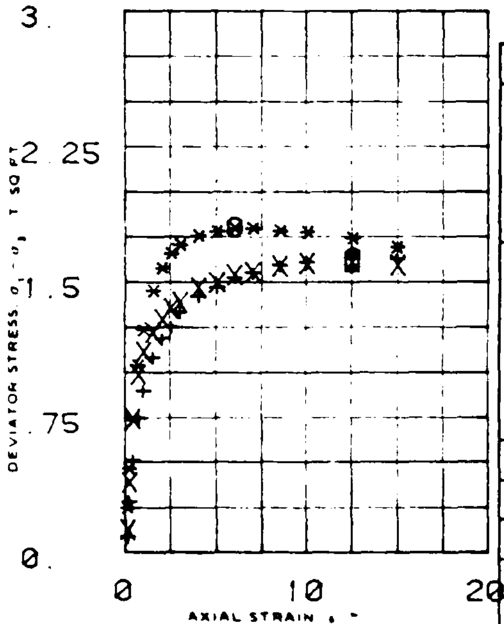
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089
REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 7







SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	21.3	21.3	23.1
	DRY DENSITY LB/CU FT	γ_{d_o}	100.7	98.3	99.7
	SATURATION, %	S_o	85.	80.	90.
	VOID RATIO	e_o	.67	.72	.69
BEFORE SHEAR	WATER CONTENT, %	w_c	20.2	22.6	22.4
	DRY DENSITY LB/CU FT	γ_{d_c}	100.9	99.4	101.2
	SATURATION, %	S_c	81.	88.	91.
	VOID RATIO	e_c	.67	.7	.67
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.63	1.8	1.61
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	22	13	24
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.63	1.7	1.59
INITIAL DIAMETER, IN		D_o	1.39	1.4	1.4
INITIAL HEIGHT, IN		H_o	2.98	2.96	2.97

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS

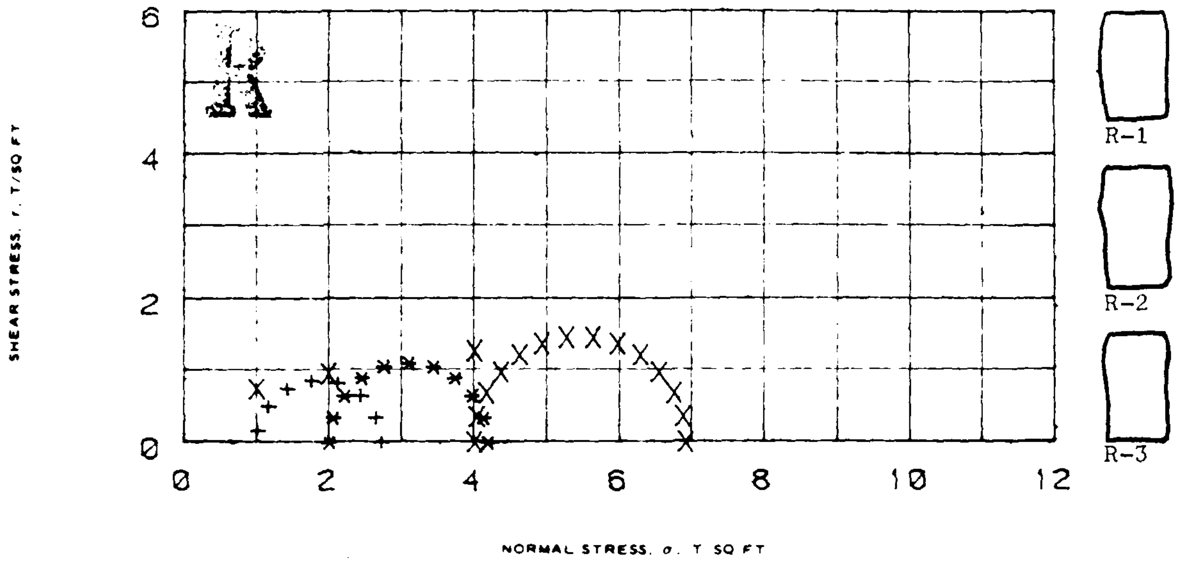
LL 28	PL 14	PI 14	Gs 2.7	TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	Q

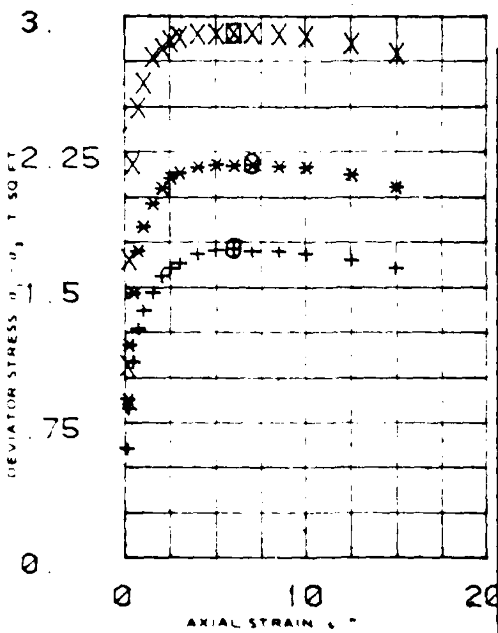
REMARKS Gray, brittle, medium consistency, low strength at PL, no shine, fast shake reaction, some sand and gravel present. Assumed a specific gravity of 2.70.

PROJECT	CHASKA FLOOD CONTROL NCS-IA-80-118-ED-H		
BORING NO	80-28M	SAMPLE NO	2
DEPTH ELEV	26.0-26.9		
LABORATORY	80/227	DATE	30 DEC 1980

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) Figure 11





			1	2	3	
SPECIMEN NO			1	2	3	
INITIAL	WATER CONTENT %	w_o	24.9	23.8	29.4	
	DRY DENSITY LB/CU FT	γ_{d_o}	87.8	88.2	82.3	
	SATURATION %	S_o	73.	78.	76.	
	VOID RATIO	e_o	.93	.91	1.06	
BEFORE SHEAR	WATER CONTENT %	w_c	32.6	32.7	33.9	
	DRY DENSITY LB/CU FT	γ_{d_c}	89.1	91.9	90.	
	SATURATION %	S_c	99.	100.	100.	
	VOID RATIO	e_c	.89	.84	.87	
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.5	5.5	5.5	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.72	2.19	2.91	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	52	58	52	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.61	2.06	2.79	
INITIAL DIAMETER, IN		D_o	1.4	1.4	1.41	
INITIAL HEIGHT, IN		H_o	2.98	2.97	2.98	

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CH

LL 51	PL 18	PI 33	Gs 2.7	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R

REMARKS

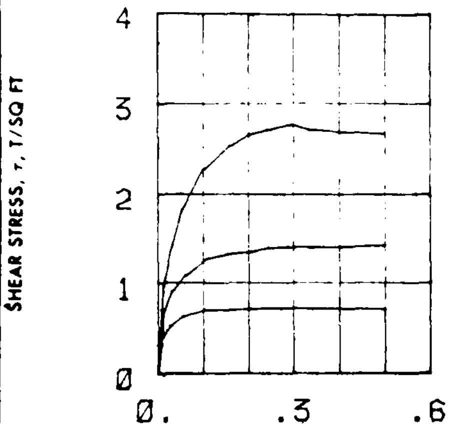
PROJECT CHASKA FLOOD CONTROL NCS-IA-80-110-ED-HF

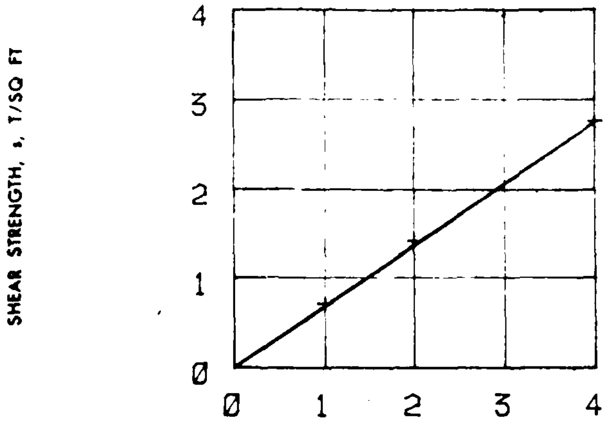
BORING NO 80-28M	SAMPLE NO 1
DEPTH ELEV 21.0-22.0	
LABORATORY 80/227	DATE 30 DEC 1980

TRIAXIAL COMPRESSION TEST REPORT

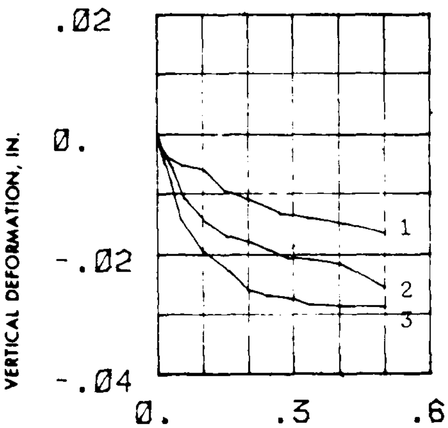
ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 8





NORMAL STRESS, σ, T/SQ FT



HORIZ. DEFORMATION, IN.

TEST NO.			1	2	3	
INITIAL	WATER CONTENT	w_o	24.6 %	24.1 %	24. %	%
	VOID RATIO	e_o	.81	.84	.88	
	SATURATION	S_o	82. %	78. %	75. %	%
	DRY DENSITY, LB/CU FT	γ_d	92.9	91.6	9Ø.3	
VOID RATIO AFTER CONSOLIDATION		e_c	.79	.78	.72	
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	28.3 %	26.2 %	23.0 %	%
	VOID RATIO	e_f	.74	.71	.62	
	SATURATION	S_f	1ØØ. %	100%	100 %	%
NORMAL STRESS, T/SQ FT		σ	1.	2.	4.	
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.73	1.43	2.77	
ACTUAL TIME TO FAILURE, MIN		t_f	69Ø	147Ø	78Ø	
RATE OF STRAIN, IN./MIN		X .ØØØ1	3.57	3.4	3.71	
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.7	1.43	2.66	

SHEAR STRENGTH PARAMETERS

ϕ' = 34.7°

TAN ϕ' = 0.692

c' = ________ T/SQ FT

S

☐ CONTROLLED STRESS

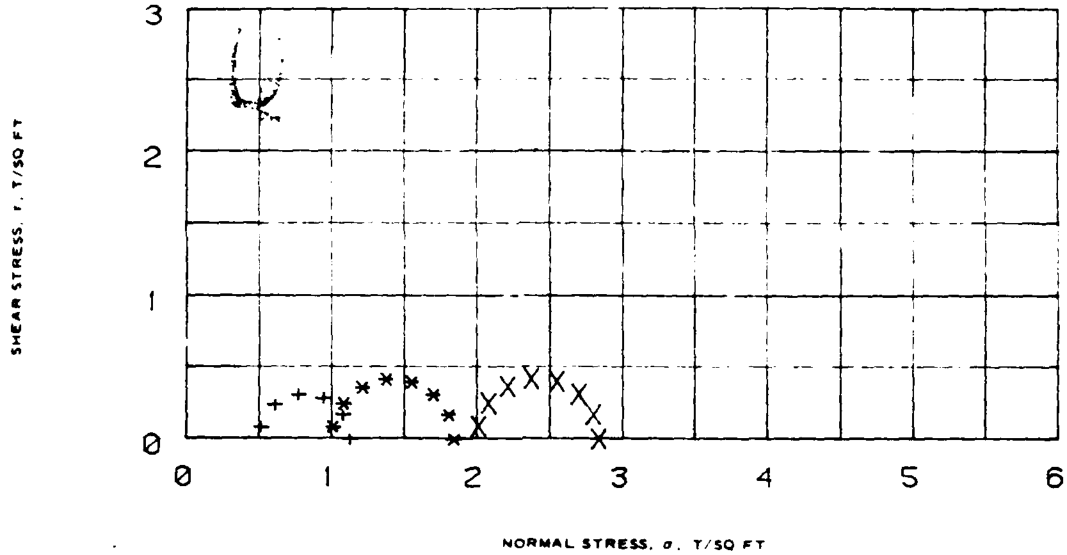
☒ CONTROLLED STRAIN

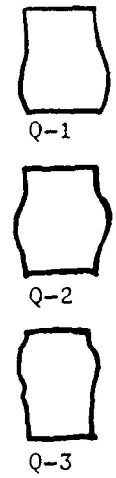
TYPE OF SPECIMEN	UNDISTURBED	3. IN. SQUARE	.5Ø6 IN. THICK
CLASSIFICATION	Sandy clay, CH		
LL 51	PL 18	PI 33	G_s 2.7

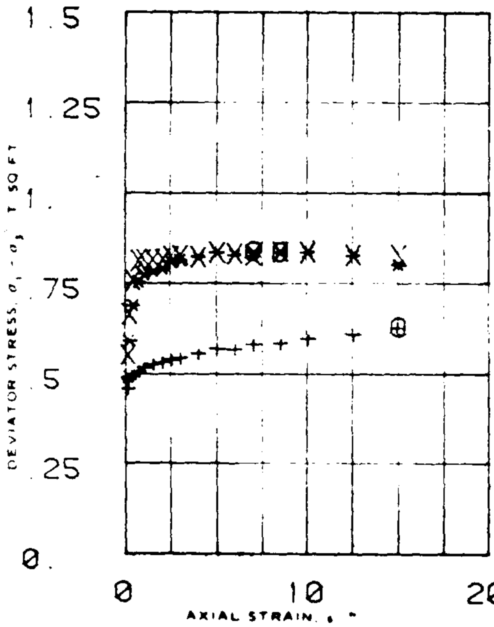
REMARKS ________

PROJECT	CHASKA FLOOD CONTROL NCS-IA-8Ø-118-ED-HF		
AREA	NRD LAB NO: 8Ø/227		
BORING NO	8Ø-29M	SAMPLE NO	1
DEPTH EL	21.Ø-22.9	DATE	30 DEC 1980

DIRECT SHEAR TEST REPORT Plate 5-21







			1	2	3	
SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	9.5	9.6	9.5	
	DRY DENSITY LB/CU FT	γ_{d_o}	113.2	113.	113.7	
	SATURATION, %	S_o	49.	49.	50.	
	VOID RATIO	e_o	.54	.54	.53	
BEFORE SHEAR	WATER CONTENT, %	w_c	19.9	20.9	20.	
	DRY DENSITY LB/CU FT	γ_{d_c}	112.	111.7	112.3	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	.55	.56	.55	
	FINAL BACK PRESSURE, T/SQ FT	u_o	7.7	7.7	7.7	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.628	.839	.837	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	32	15	19	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.628	.805	.828	
INITIAL DIAMETER, IN		D_o	1.41	1.41	1.41	
INITIAL HEIGHT, IN		H_o	2.99	3.	3.	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CL

LL 34	PL 13	PI 21	Gs 2.79	TYPE OF SPECIMEN REMOLDED	TYPE OF TEST Q

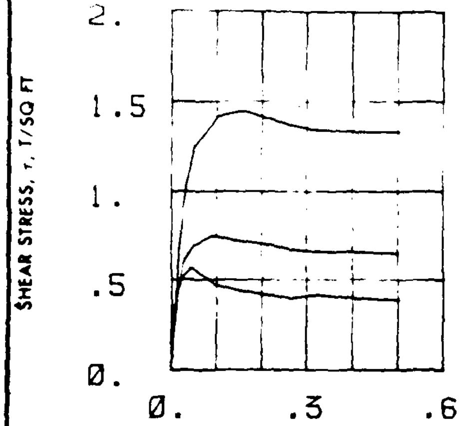
REMARKS Remolded at a dry density (112 pcf) and a water content (9.5%). Similar to undisturbed direct shear specimens. All specimens were back pressure saturated before shearing.

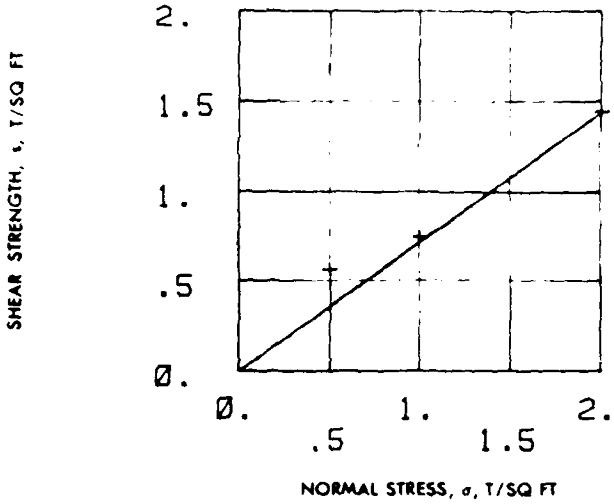
PROJECT	CHASKA FLOOD CONTROL NCS-IA-80-118-ED-HF
BORING NO. 80-24M	SAMPLE NO. 2
DEPTH ELEV	10.0-11.0
LABORATORY 80/227	DATE 30 DEC 1980

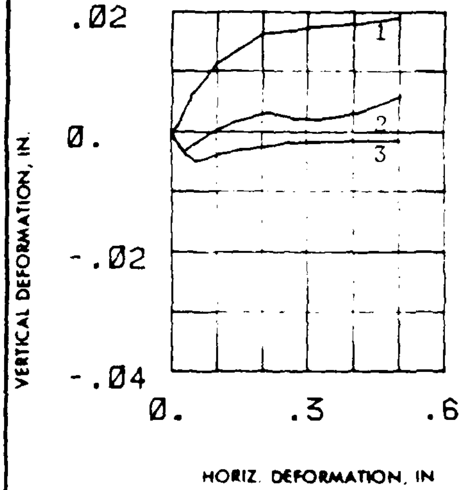
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 1







SHEAR STRENGTH PARAMETERS

φ = 35.9°

TAN φ = 0.725

c' = ______ T/SQ FT

S

[ ] CONTROLLED STRESS

[X] CONTROLLED STRAIN

TEST NO.			1	2	3	
INITIAL	WATER CONTENT	w_o	9.9 %	8. %	8.7 %	%
	VOID RATIO	e_o	.49	.5	.51	
	SATURATION	S_o	56. %	45. %	47. %	%
	DRY DENSITY, LB/CU FT	γ_d	116.8	116.3	115.1	
VOID RATIO AFTER CONSOLIDATION		e_c	.5	.49	.48	
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	17. %	15. %	15.2 %	%
	VOID RATIO	e_f	.51	.49	.48	
	SATURATION	S_f	94. %	86. %	88. %	%
NORMAL STRESS, T/SQ FT		σ	.5	1.	2.	
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.57	.75	1.45	
ACTUAL TIME TO FAILURE, MIN		t_f	180	300	450	
RATE OF STRAIN, IN/MIN		X .0001	2.44	2.93	3 4	
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.4	.65	1.33	

TYPE OF SPECIMEN UNDISTURBED	3. IN. SQUARE	1.01 IN. THICK	
CLASSIFICATION Sandy clay, CL			
LL 34	PL 13	PI 21	G. 2.79

REMARKS Brown, brittle, hard consistency, medium strength at PL, gloss shine, slow shake reaction, surficial cracks, highly calcareous

PROJECT CHASKA FLOOD CONTROL NCS-IA-80-118-ED-HF

AREA MRD LAB NO: 80/227

BORING NO. 80-24M SAMPLE NO 2

DEPTH/EL 10.0-11.1 DATE 30 DEC 1980

DIRECT SHEAR TEST REPORT Plate 5-23

ENG FORM

GPO 1966 OF—714-545

SOIL CLASSIFICATION RECORD SHEET

* By St. Paul District
** By MRD Laboratory

Project: Chaska Minnesota Flood Control Project	Boring No: 80-23M through 80-25M	MRD Lab No: 80/227
Station:	Range:	Surf Elev:
Depth To Water Table:	Bottom Of Hole:	

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits) L L	P I	Grading (Cumulative Percents Finer) Hyd Analysis Fines .005	.02mm	200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1½	3	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	* Classification Tech MEMO 3-357, May 67	* Remarks **P.L.
Hole 80-23M																							
2	4.2						65	79	86	90	95	97	[illegible]	100								ML	15
3	6.0	14.8	35	21			50	66	80	87	92	96	100									SC-CL	
4	10.8	16.4					13	24	61	83	92	96	97	100								SC	
5	12.1	3.5																				SP	
6	16.1	17.2	38	25			47	63	79	86	90	92	95	100								SC	13
8	20.5	26.7																				CL	
9	21.0	28.7																				CL	
10	22.3	16.8					48	[illegible]	94	99	100											SC	
11	24.3	9.7																				CL	
12	26.5						5	27	87	99	100						0.27	0.17	0.093	2.9	1.2	SP-SM	
14	39.0						8	[illegible]	80	97	100						0.28	0.18	0.082	3.4	1.4	SP-SM	
Hole 80-24M																							
2	4.5	21.8	19	1			47	71	83	91	96	98	100									SM-SC	15
3	7.2	13.2																				GC-SC	
4	11.0	15.4	34	*21			52	66	81	88	[illegible]	96	98	100								CL	
5	16.3	14.4	31	12			48	63	[illegible]	93	97	100										SC	19
6	17.5	21.7	45	[illegible]																		CL	18
9	30.9	22.3	17	4																		CL-ML	13
Hole 80-25M																							
5	6.9	10.2					40	[illegible]	[illegible]	87	[illegible]	[illegible]	[illegible]	100								SC	
6	13.4						[illegible]	[illegible]	[illegible]	46	[illegible]	[illegible]					[illegible]	0.48	0.16	7.5	1.2	SP-SC	
9	21.5						[illegible]	[illegible]	[illegible]	81	[illegible]	[illegible]	[illegible]	100								SC	
10	24.2	15.5					[illegible]	[illegible]	[illegible]	90	91	[illegible]	94	94	100							SC	
12	31.7						No sample received																
13	39.6						No sample received																
14	41.9						No sample received																
15	49.3	11.4																				OH	
16	51.1	23.3	38	[illegible]																		CL	13

MRD FORM 16 NOV 75 EDITION OF MAY 70 IS OBSOLETE

SOIL CLASSIFICATION RECORD SHEET

* By St. Paul District
** By MRD Laboratory

Project	Boring No	MRD Lab No
Chaska Minnesota Flood Control Project	80-26M through 80-28M	50-[illegible]

Station	Range	Surf Elev	Depth To Water Table	Bottom Of Hole

Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits) L L	P I	Grading (Cumulative Percents Finer) Hyd Analysis Fines .005	.02mm	U S Standard Sieve Sizes 200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1½	3 in
Hole 80-26M																
1	2.0						30	37	44	47	50	51	59	6[illegible]	85	100
2	6.0						64	69	75	78	81	86	87	92	100	
4	11.2	17.[illegible]	[illegible]	3[illegible]			93	96	98	99	100					
[illegible]	15.[illegible]	21.3														
7	21.0	26.2	52	31*			45	85	99	99	100					
8	26.3	39.4														
9	27.3	30.1														
11	31.1	27.9														
13	41.3	*18.8	42	27*			No sample received									
14	46.3	24.6	21	4												
Hole 80-27M																
1	4.0	14.3														
2	5.0	21.[illegible]	29	23												
3	1[illegible]						6[illegible]	[illegible]	[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100
[illegible]	2[illegible]	[illegible]	[illegible]	1												
[illegible]	[illegible]	2[illegible]														
Hole 80-28M																
2	6.[illegible]						[illegible]	11	[illegible]	1[illegible]	[illegible]	[illegible]	59	[illegible]	100	
[illegible]	[illegible]	1[illegible]						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				
[illegible]	11.[illegible]	1[illegible]	12	[illegible]												
[illegible]	11.[illegible]	[illegible]	11	21												
[illegible]	1[illegible]						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]												
1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]*			[illegible]	1[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			

Sample No	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	*Classification Tech MEMO 3-357, May 67	*Remarks
Hole 80-26M							
1						GC	
2						CL	
4						CH	
[illegible]						CL	
7						SC	
8						CL	
9						CL	
11						CL	
13						CL-ML	
14						CL-ML	
Hole 80-27M							
1						[illegible]-M[illegible]	
2						CL	
3	[illegible]	[illegible]	[illegible]	[illegible]	0.91	[illegible]-M	
[illegible]						CL-ML	
[illegible]						ML-CL	
Hole 80-28M							
2	2.0	0.17	0.17	11.5	0.63	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.[illegible]	[illegible]	
[illegible]						[illegible]	
[illegible]						[illegible]	
[illegible]						[illegible]	
[illegible]						CH	
1[illegible]						[illegible]	

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SOIL CLASSIFICATION RECORD SHEET

Project		Boring No	MRD Lab No
Station	Surf Elev	Depth To Water Table	Bottom Of Hole

Sample No	Depth To Bottom Of Sample	Moisture	Plasticity (Atterberg Limits)	Gradation (Percent Finer)	Gradation Curve Analysis	* Classification Tech MEMO 3-357, May 67	* Remarks **P.L.
[illegible]	[illegible]					[illegible]	[illegible]

SOIL CLASSIFICATION RECORD SHEET

Depth To Water Table

Sieve Analysis

SOIL CLASSIFICATION RECORD SHEET

Sample No.	Depth to Bottom of Sample	Moisture				Remarks

MRD FORM
NOV 75 16

SOIL CLASSIFICATION RECORD SHEET

			Boring No.	MR...
	Range	... Elev.	Depth To Water Table	...

	Plasticity Atterberg Limits	Grading (Cumulative Percent Finer)	... Analysis	... Tech MEMO ... 3-357, May 67	Remarks

... MAY 70 IS OBSOLETE

SOIL CLASSIFICATION RECORD SHEET

*By St. Paul District
**By MRD Laboratory

Project	Boring No	MRD Lab No 79/120
Station / Range / Surf Elev	Depth To Water Table	Bottom Of Hole

Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits) LL	Plasticity (Att Limits) PI	Grading (Cumulative Percents Finer)	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification * Tech MEMO 3-357, May 67	Remarks* P.I.**
											SM	
											SP-SM	
											SP-SM	
											SP-SM	
											SP-SM	
											SM	
											CL	16
											SM	
											SP-SM	
											CL	15
											CL	19
											CL	20
											CL	21
											SP-SM	
											CL	
										1.4	SP-SM	
											ML	
											ML+SP	From Log
											SM	
											CL	18
											SM+ML+OL	From Log
											CL	17
											SM	Grad. for #18

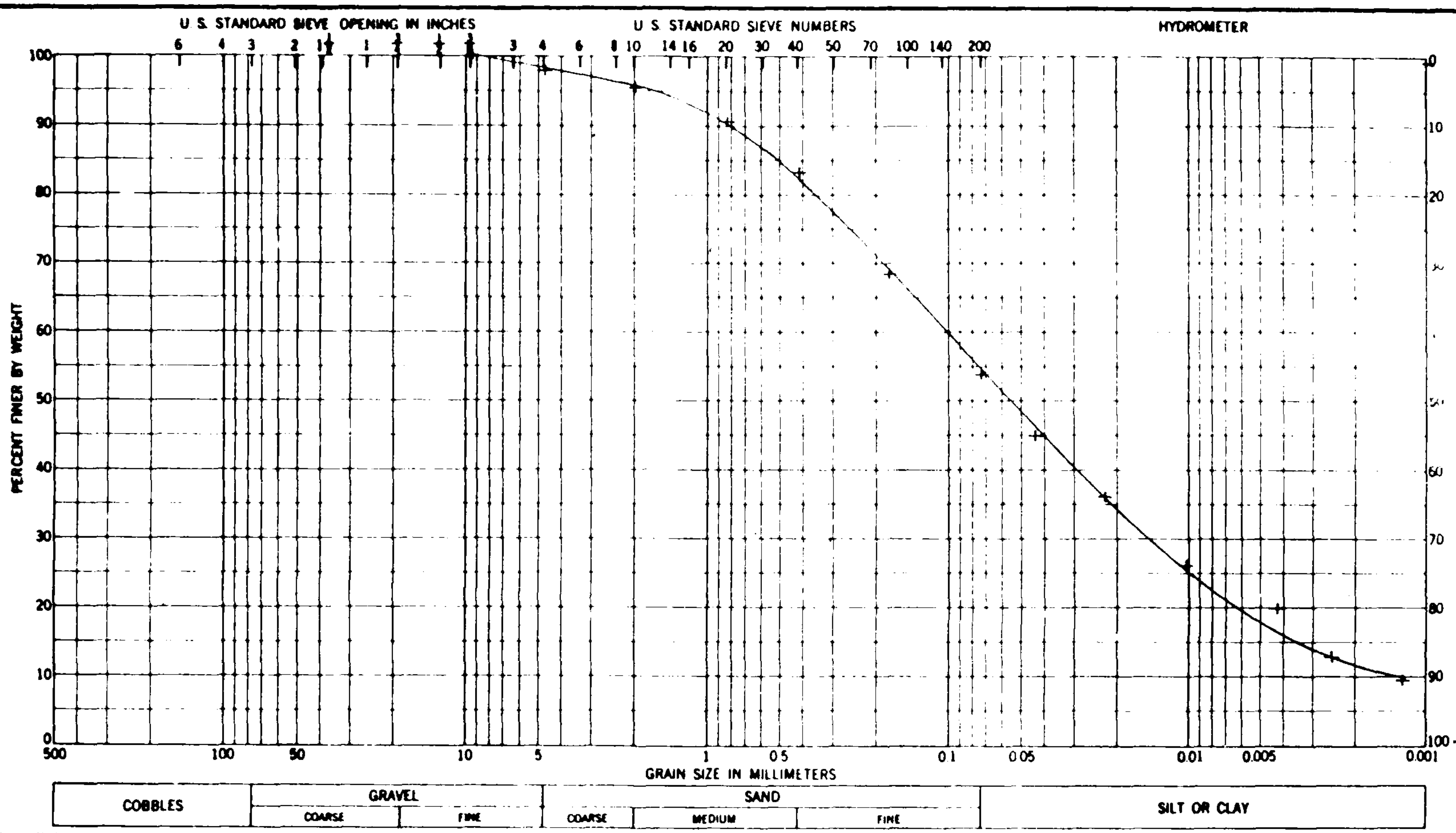
MRD FORM 16, NOV 75 — EDITION OF MAY 70 IS OBSOLETE

SOIL CLASSIFICATION RECORD SHEET

Project: [illegible], Missouri [illegible] Flood Control	Boring No: [illegible]	MRD Lab No: [illegible]
Station / Range / Surf Elev:	Depth To Water Table	Bottom Of Hole

Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits) L L	P I	Grading (Cumulative Percents Finer) Hyd Analysis Fines .005	.02mm	U S Standard Sieve Sizes 200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1 1/2	3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification * Tech MEMO 3-357, May 67	Remarks
[illegible]	[illegible]M																						
	[illegible]						6	1[illegible]	3[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100			0.81	0.35	[illegible]	5.8	1.1	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]																			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]																			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			33	[illegible]	100													[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]																			
[illegible]	[illegible]	[illegible]	46	[illegible]																			
[illegible]	[illegible]M																						
	[illegible]	[illegible]	[illegible]	[illegible]																		[illegible]	
[illegible]	12.0	[illegible]	[illegible]	[illegible]																		[illegible]	
[illegible]	13.5	[illegible]																					
[illegible]	[illegible].0	[illegible]	[illegible]	[illegible]																			
[illegible]	27.0	[illegible]																				[illegible]	
[illegible]	[illegible].0	[illegible]																					
11	34.0						[illegible]	15	47	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100		[illegible]	[illegible]	0.11	[illegible]	1.0	[illegible]	

MRD FORM 16
NOV 75 EDITION OF MAY 70 IS OBSOLETE



Sample No.	Depth	Classification	Nat w %	LL	PL	PI
2	10.0-11.0	Sandy clay, CL		34	13	21

Project CHASKA FLOOD CONTROL

NCS-IA-80-118-ED-HF

Area MRD LAB NO. 80/227

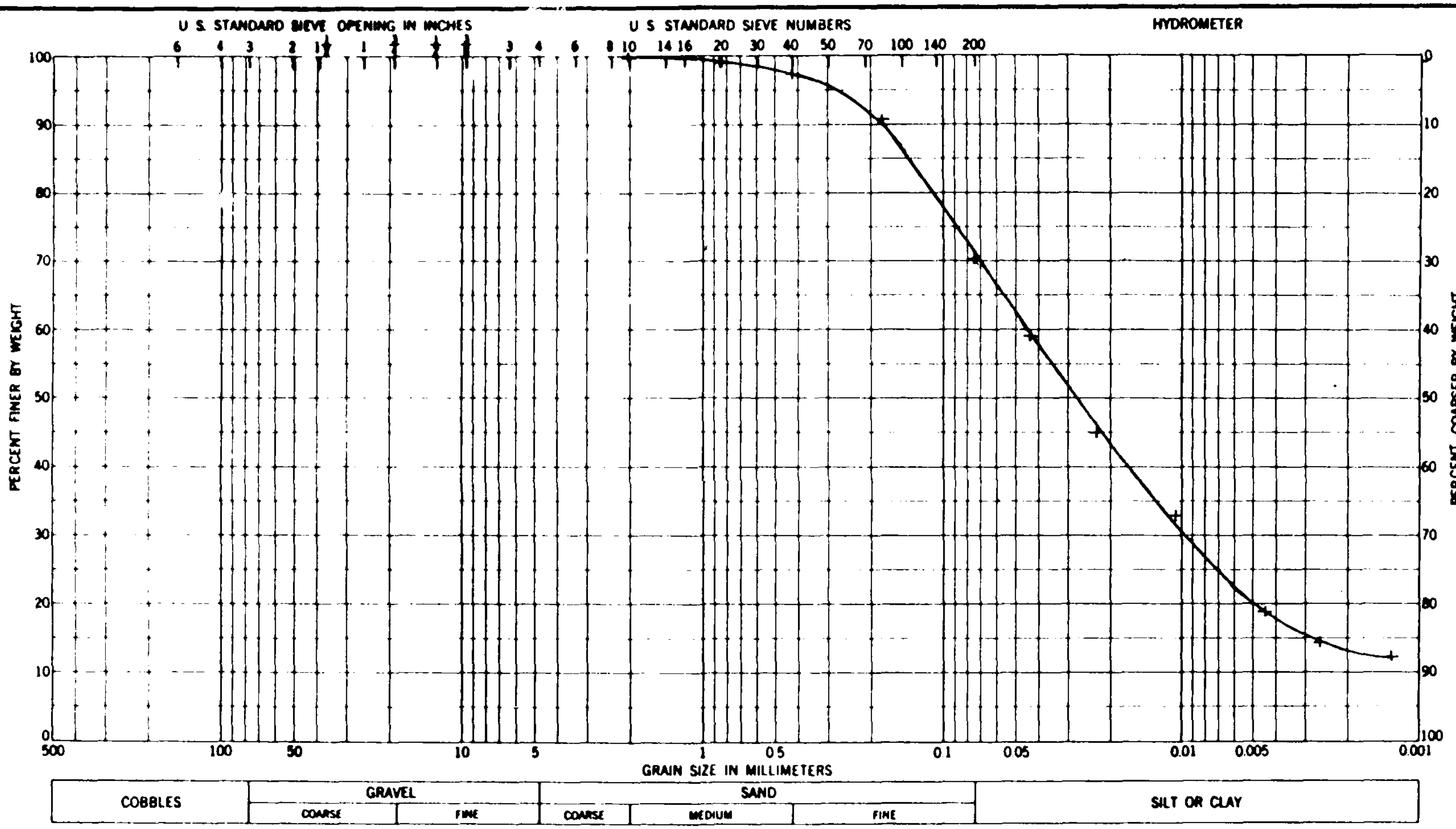
Boring No. 80-24M

Date 30 DEC 1980

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 3



Sample No.	Depth	Classification	Nat w %	LL	PL	PI
1	21.0-22.8	Sandy clay, CH		51	18	33

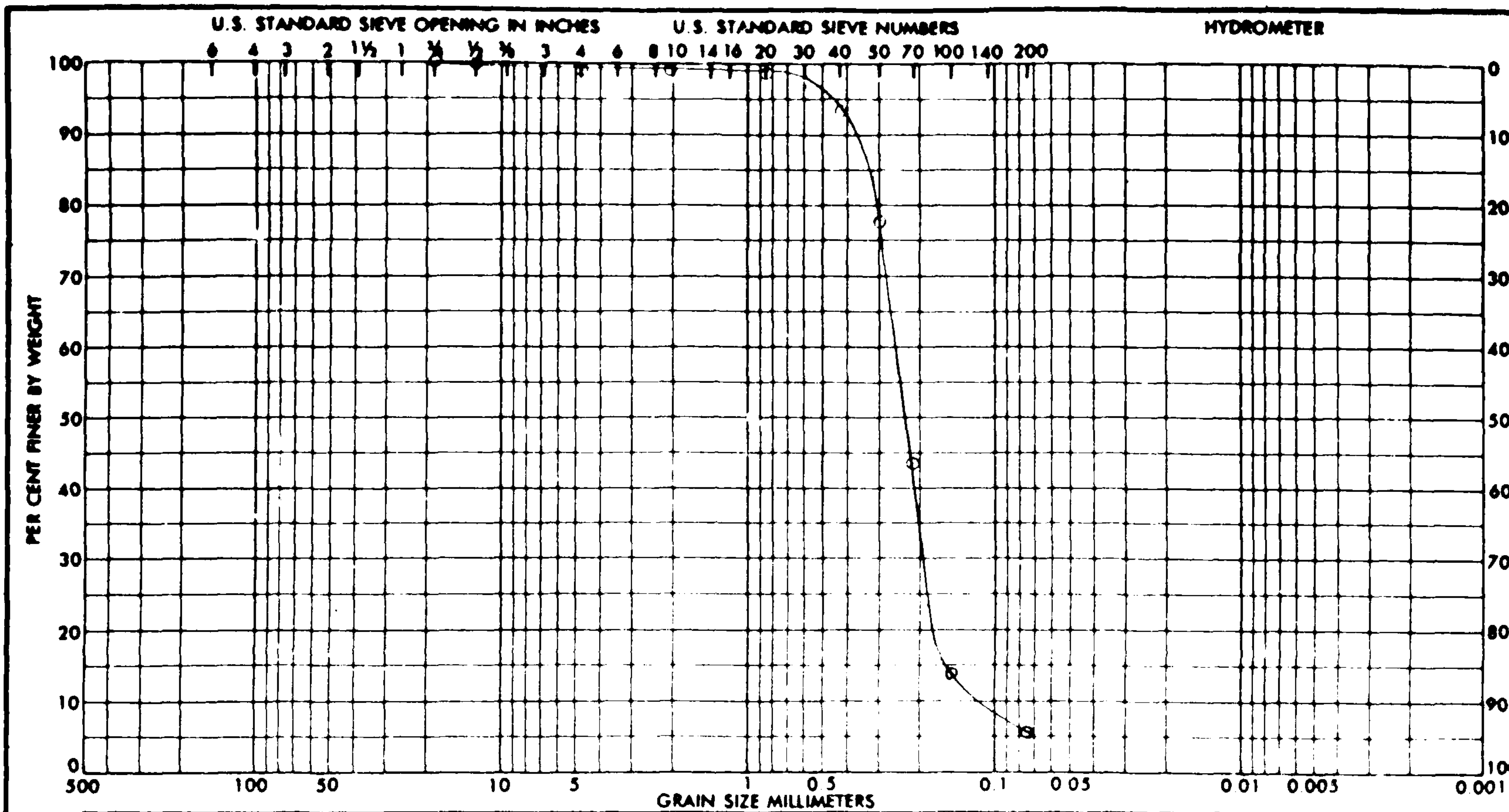
Project CHASKA FLOOD CONTROL
NCS-IA-80-118-ED-HF
Area MRD LAB NO. 80/227
Boring No. 80-28M
Date 30 DEC 1980

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 10

Plate 5-55



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
34/3Y66	145.0'-146.0'	SAND (SP-SM)			Visual	

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-1M.

DATE MAY '73

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO 1241, SEP 1962, WHICH IS OBSOLETE

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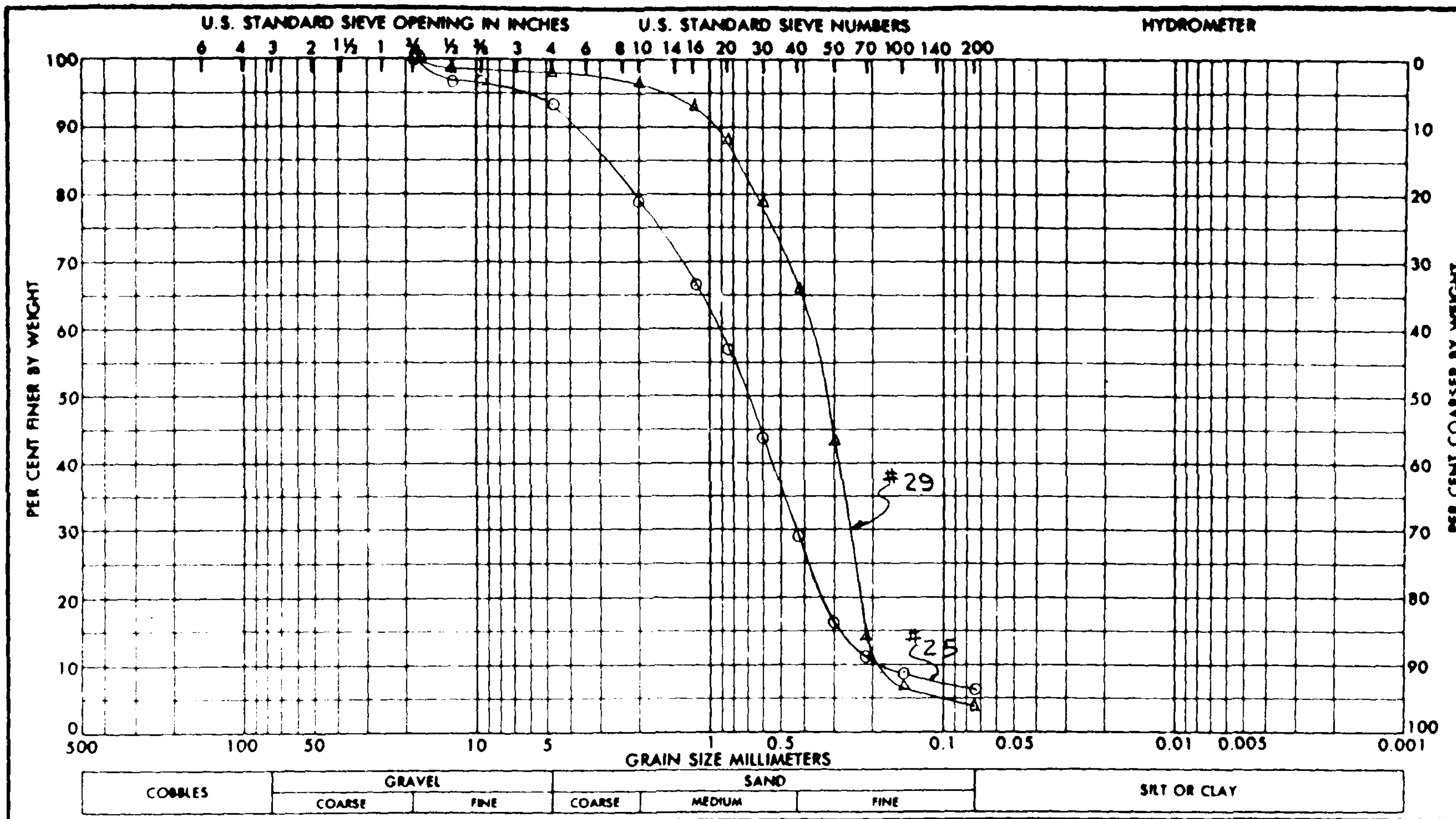


SAMPLE NO	~~ELEV~~ OR DEPTH	CLASSIFICATION	~~NAT W%~~	LL	PL	PI
25/3Y64	100.0'-100.5'	SAND (SP-SM)	o	Visual		
29/3Y65	120.0-121.0'	SAND (SP)	Δ	ditto		

PROJECT CHASKA FLOOD CONTROL

AREA

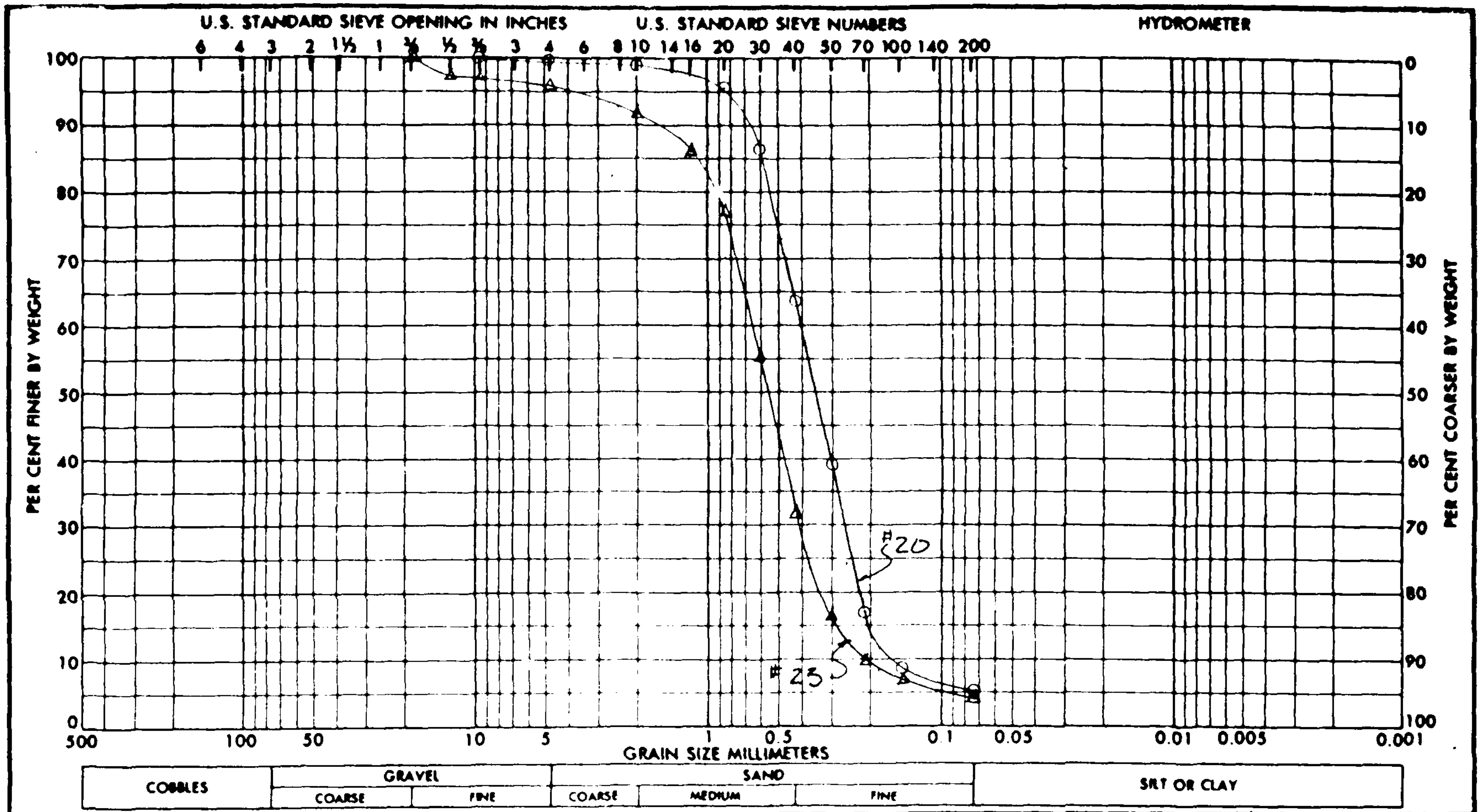
BORING NO 73-1M

DATE MAY '73

GRADATION CURVES

ENG FORM 2087 — 1 MAY 63 — REPLACES WES FORM NO 1241, SEP 1962, WHICH IS OBSOLETE

U.S. GOVERNMENT PRINTING OFFICE 1963 OF—700-126



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
20/3Y62	72.5'-73.5'	SAND (SP-SM)	○	Visual		
23/3Y63	90.0'-91.0'	SAND (SP)	Δ	ditto.		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-1M

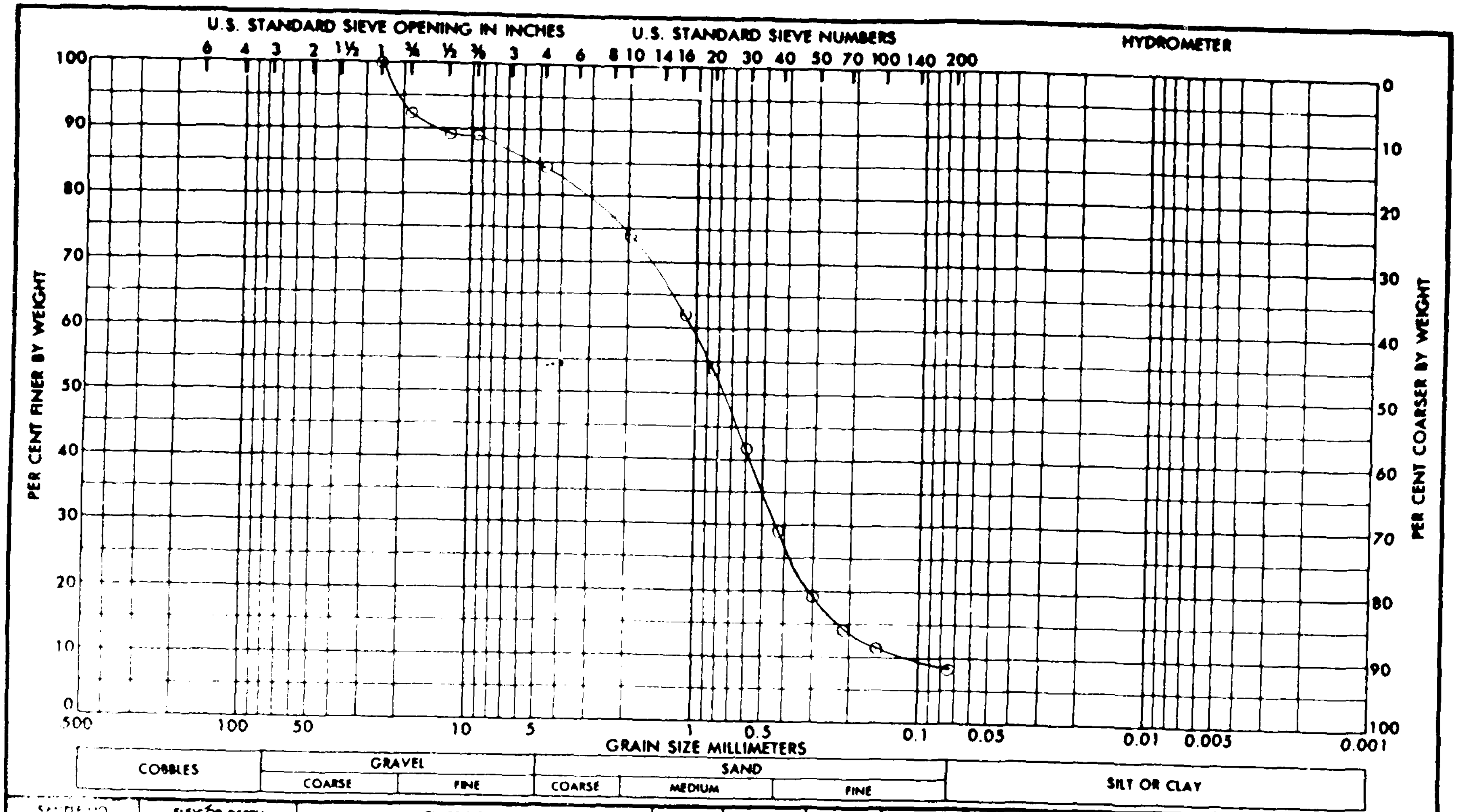
DATE MAY '73

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO 1241, SEP 1962, WHICH IS OBSOLETE

U S GOVERNMENT PRINTING OFFICE 1963 OF—700-126



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
[illegible]	57.5'-58.5'	SILTY SAND, GRAVELLY (SM-SW)		VISUAL		

PROJECT CHASKA FLOOD CONTROL

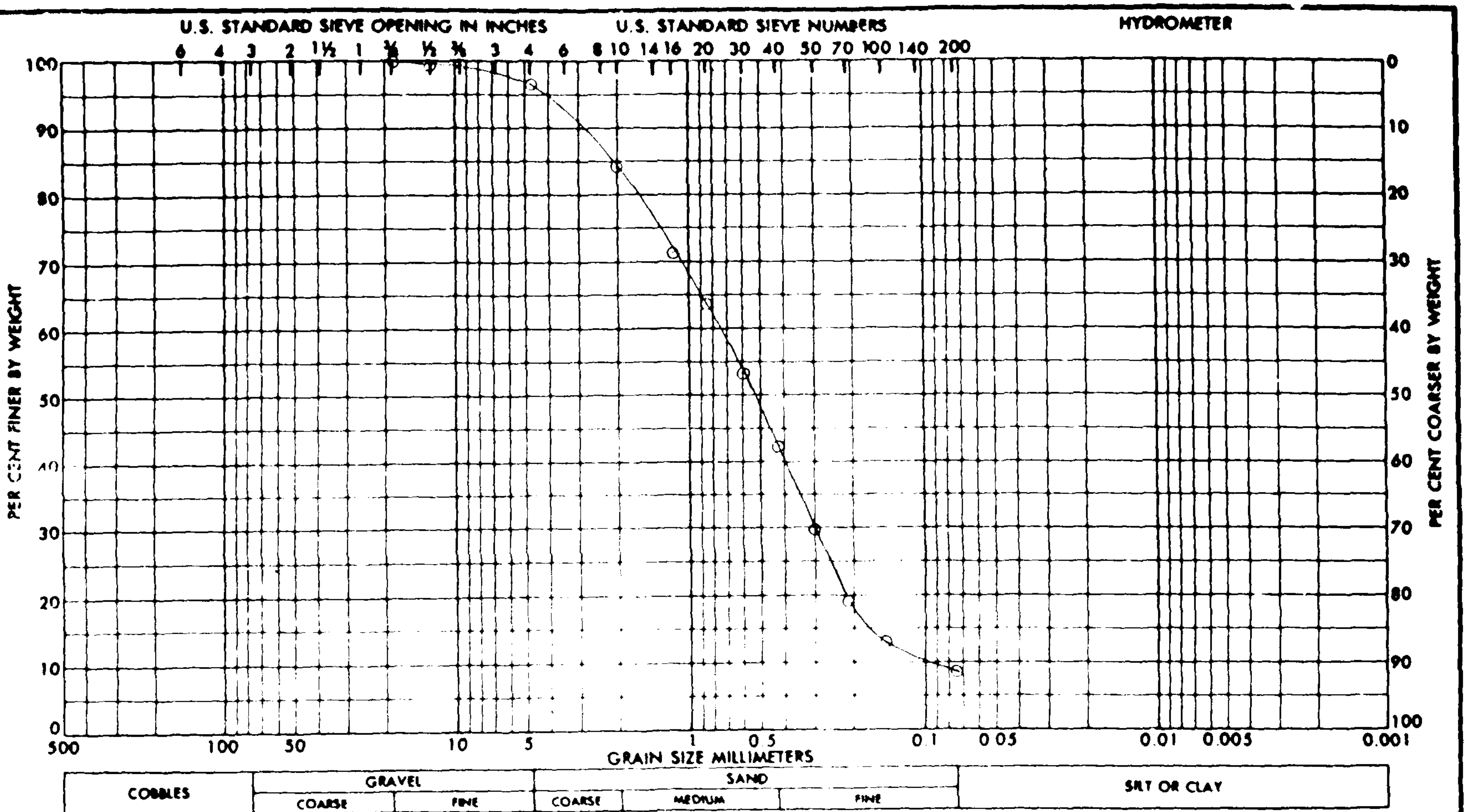
AREA

BORING NO 73-1M.

DATE MAY. '73

GRADATION CURVES

2087 REPLACES WES FORM NO 1241, SEP 1962, WHICH IS OBSOLETE



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
12/3Y60	37.5'-38.5'	SILTY SAND (SM-SW.)		VISUAL		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-1M

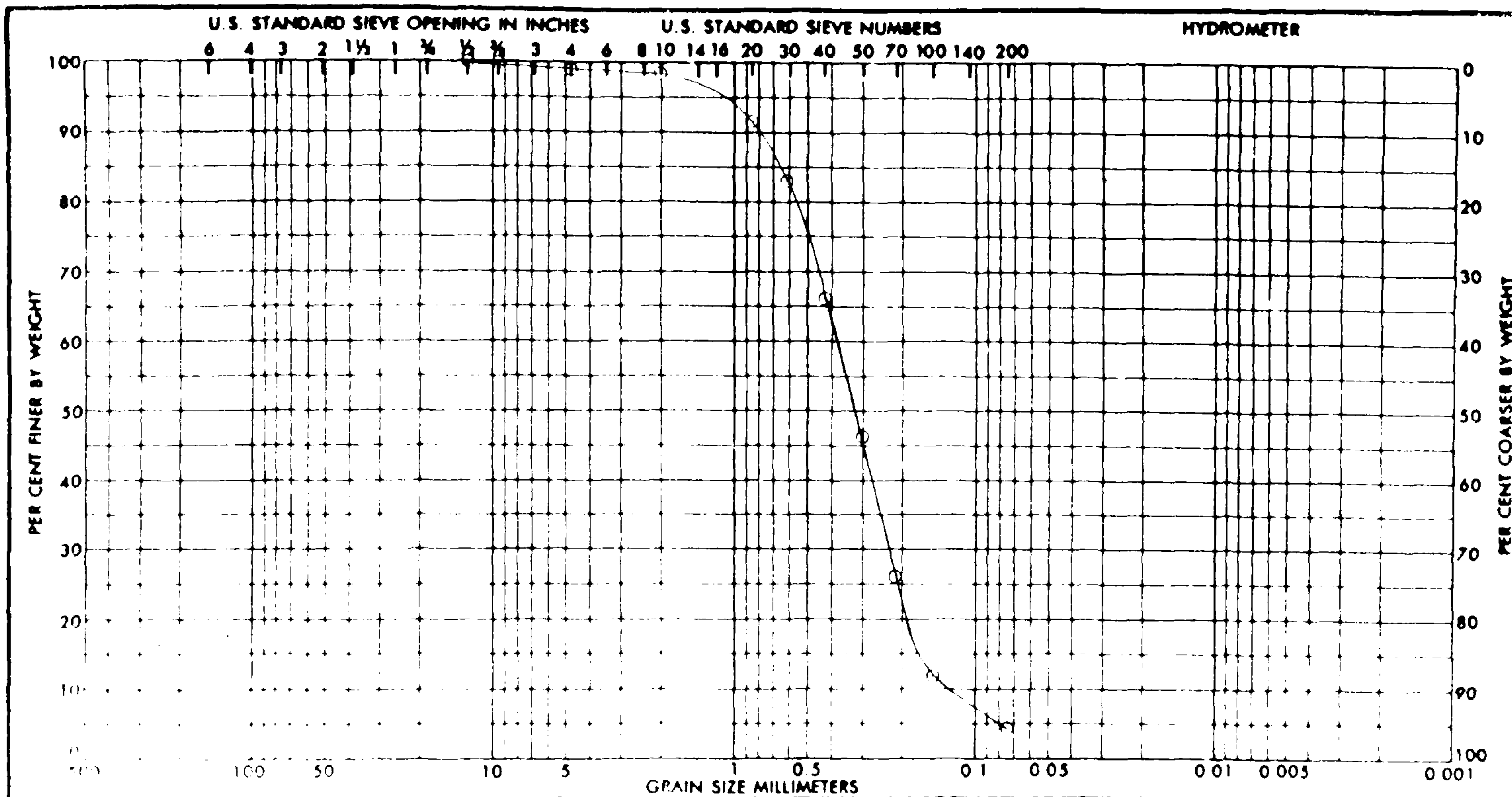
DATE MAY 73

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO 1241, SEP 1962, WHICH IS OBSOLETE

U.S. GOVERNMENT PRINTING OFFICE 1963 OF—700-180



	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

# DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
	AND (SP)		VISUAL		

PROJECT CHASKA FLOOD CONTROL

AREA

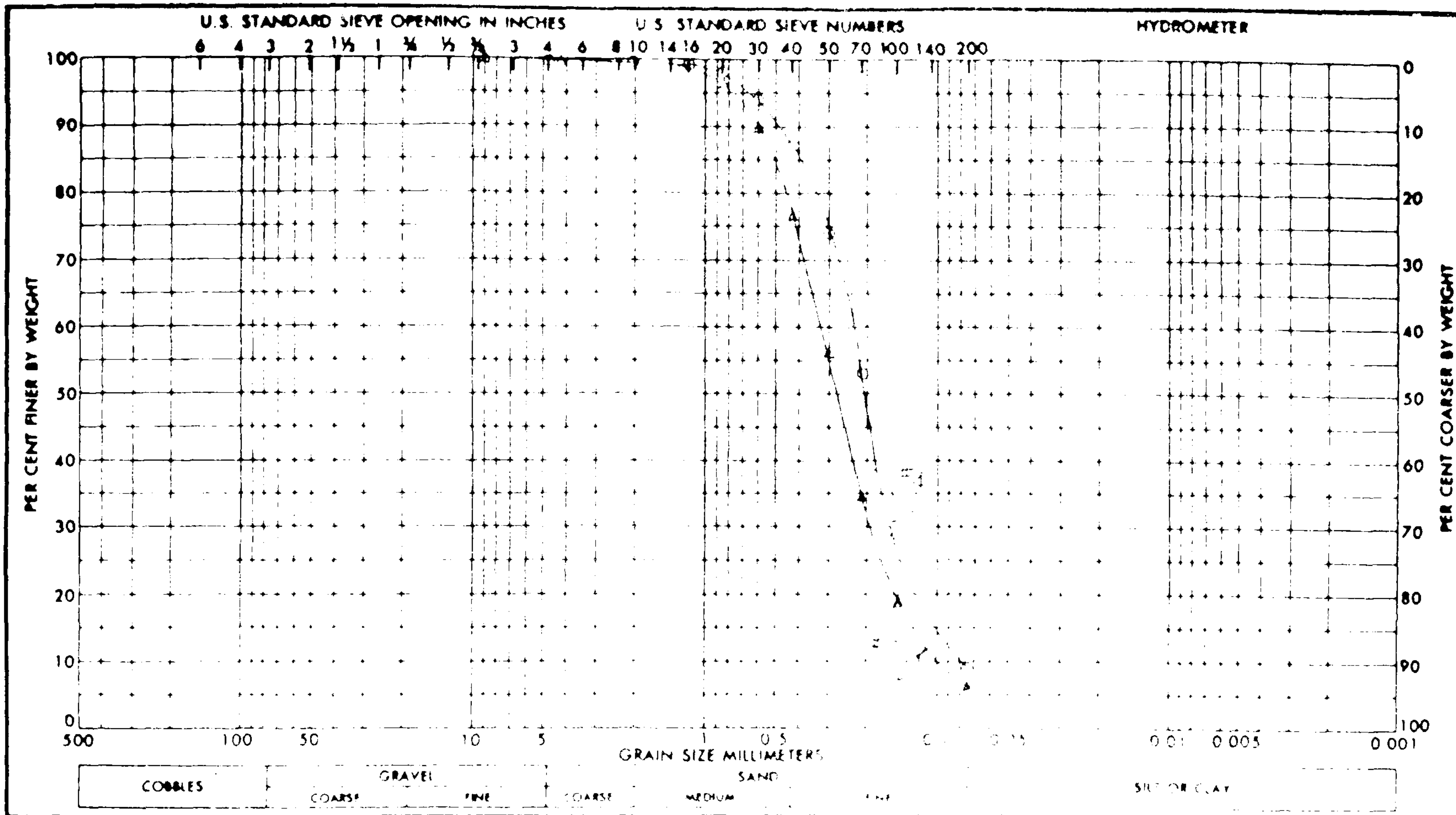
BORING NO 73-1M

DATE MAY '73

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO 1241, SEP 1962 WHICH IS OBSOLETE



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%		
4/3Y56	12.0-13.0'	SILTY SAND (SM-SP)			
7/3Y57	20.0-21.0'	SAND (SP-SM)			

PROJECT: NEBRASKA FLOOD CONTROL

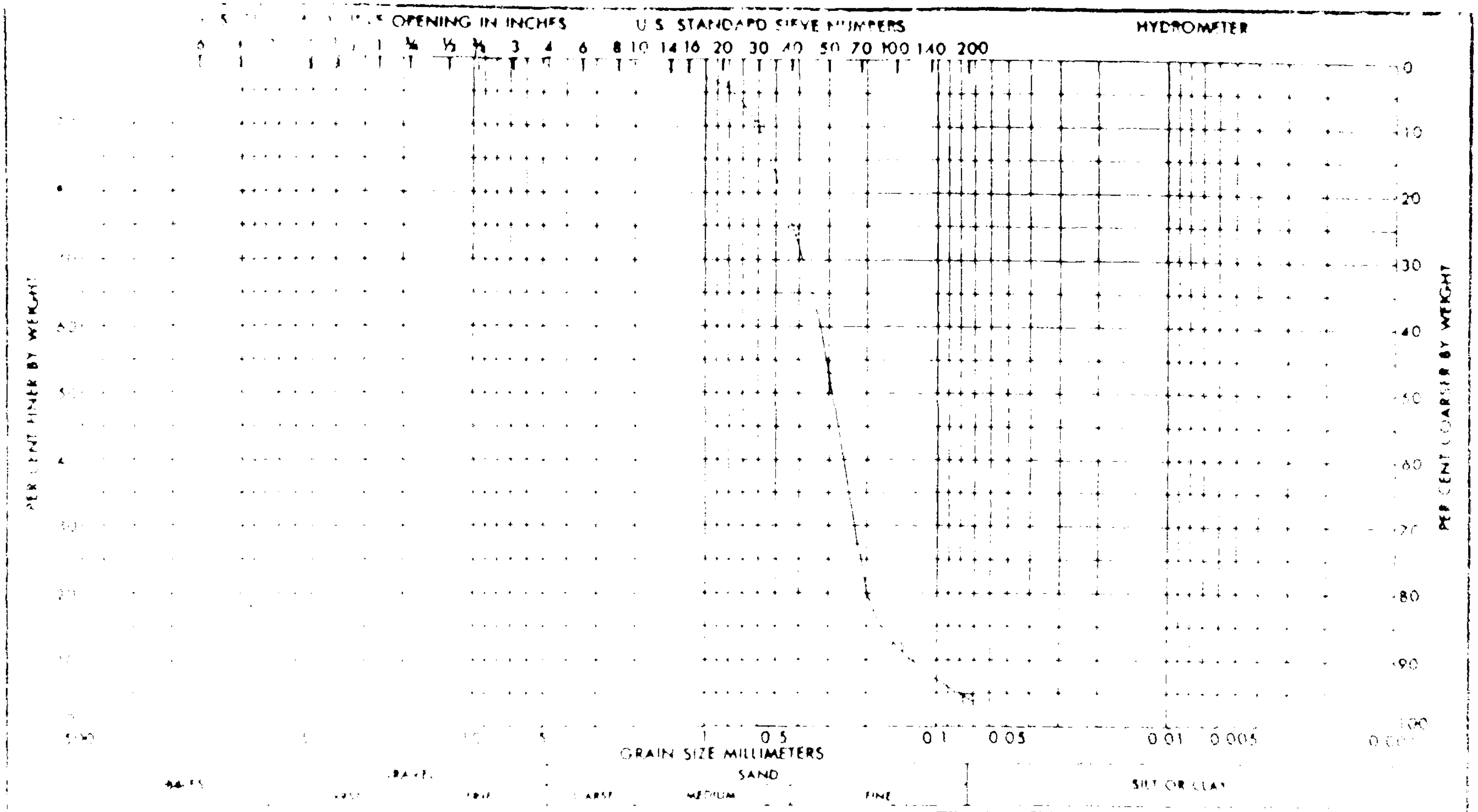
AREA

BORING NO.

DATE: MAY

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH MAY BE USED.



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
	3.5	(SM)				
		VISUAL				

PROJECT CHASKA FLOOD CONTROL

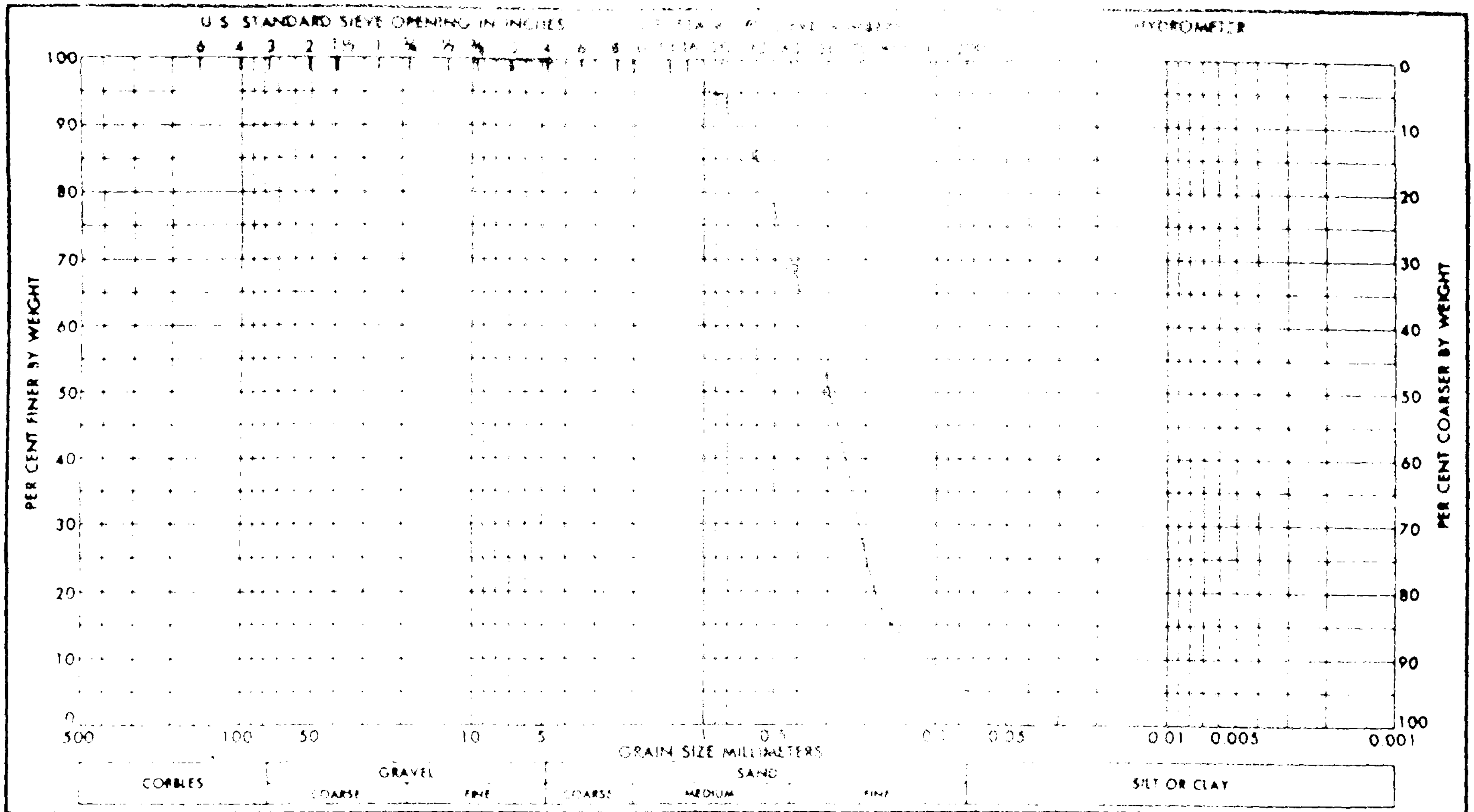
AREA

BORING NO. 73-5M

DATE MAY 73

GRADATION CURVES

ENG FORM 2087



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
[illegible]	20-45	SAND (SP-SM)		VISUAL		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO. 73-5M

DATE MAY 73

GRADATION CURVES

ENG FORM 2087
1 MAY 63

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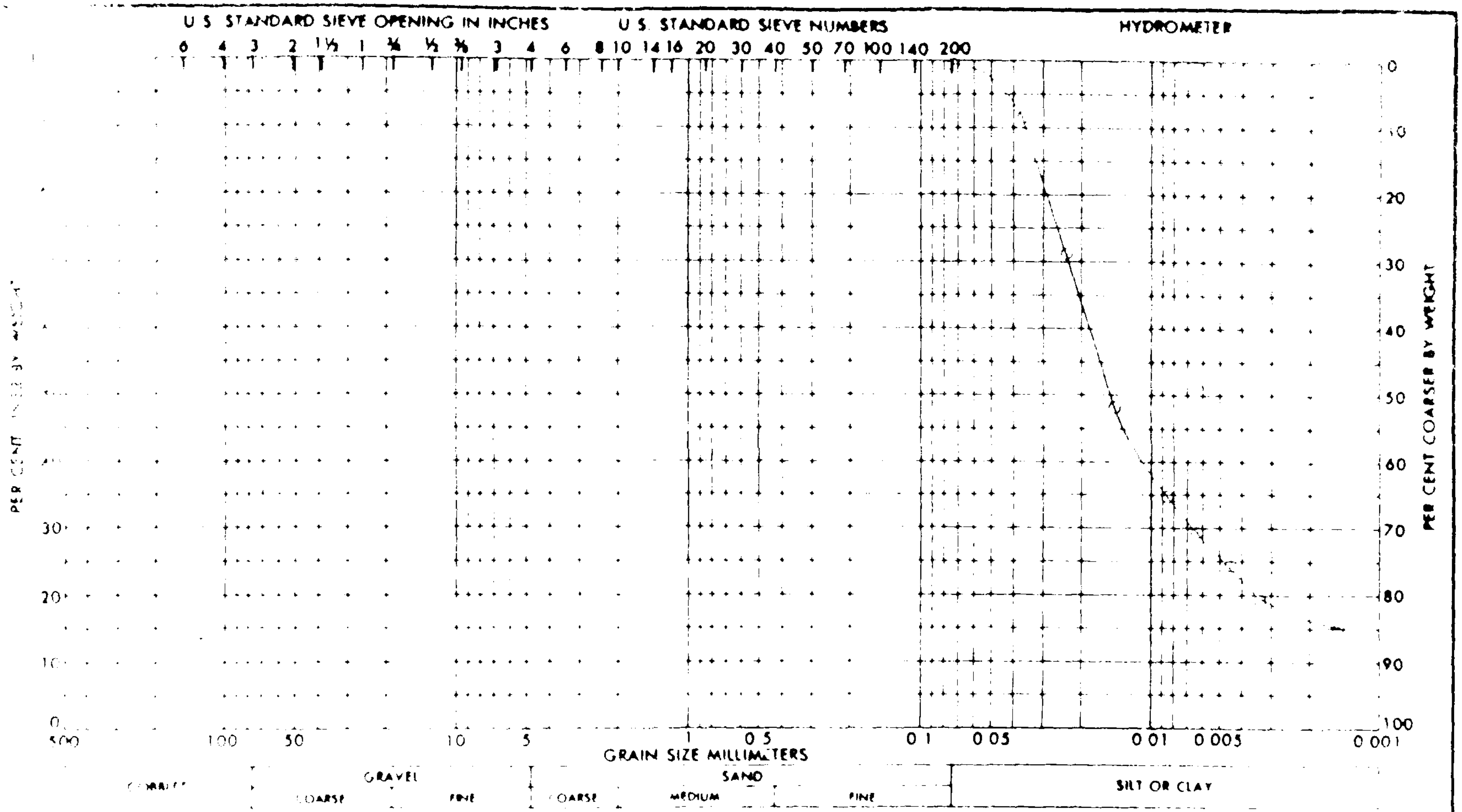

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
[illegible]	770 29.5	CLAY (CL)		34	9	5

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO. 73-5M

DATE MAY 73

GRADATION CURVES

ENG FORM 2087
MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE

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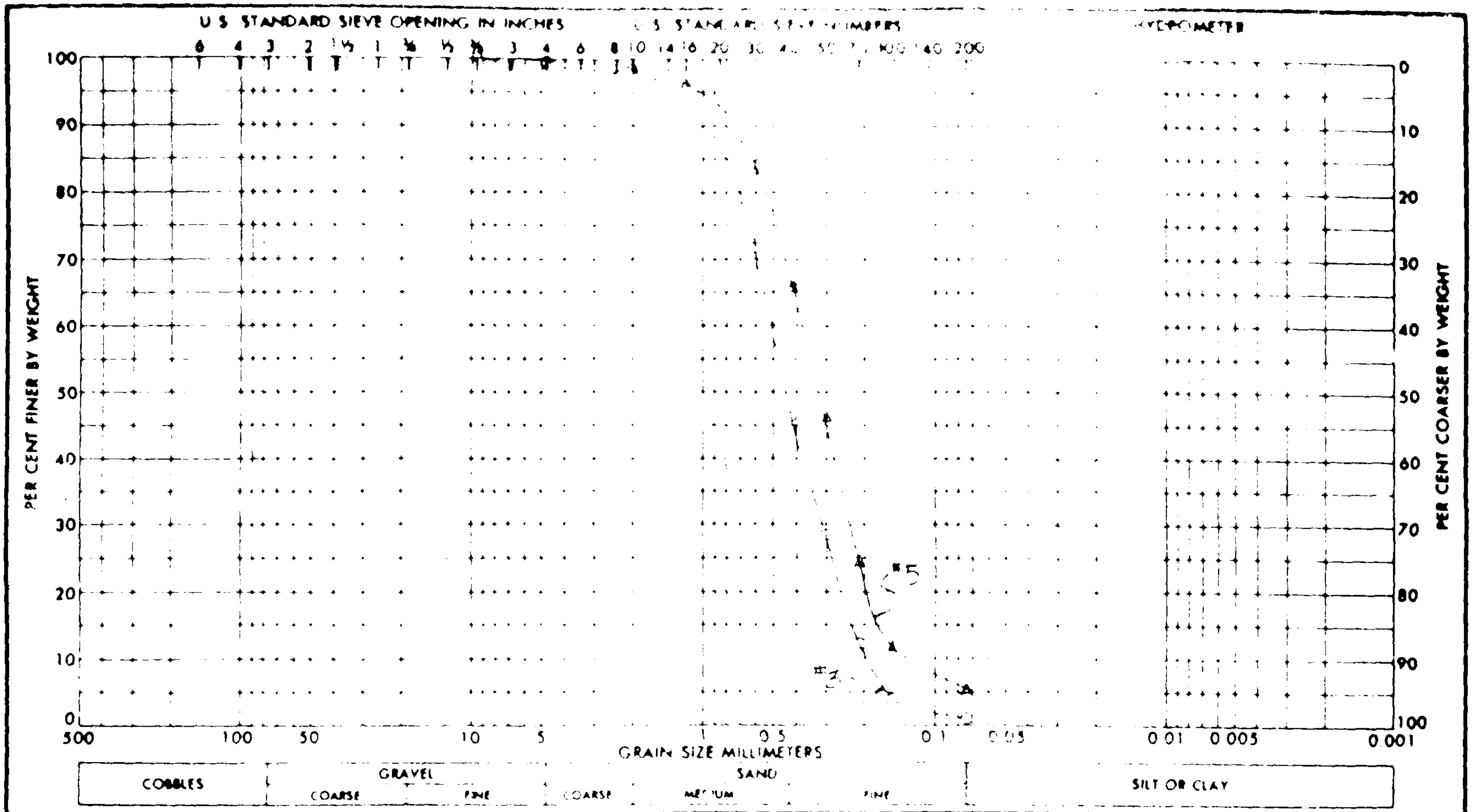

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3/3Y77	9.5'-12.0'	SAND (SP)	○	VISUAL		
5/3Y78	19.5'-22.0'	SAND (SP-SM)	△	VISUAL		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO. 73-GM

DATE MAY 73

GRADATION CURVES

ENG FORM 2087 1 MAY 63 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE

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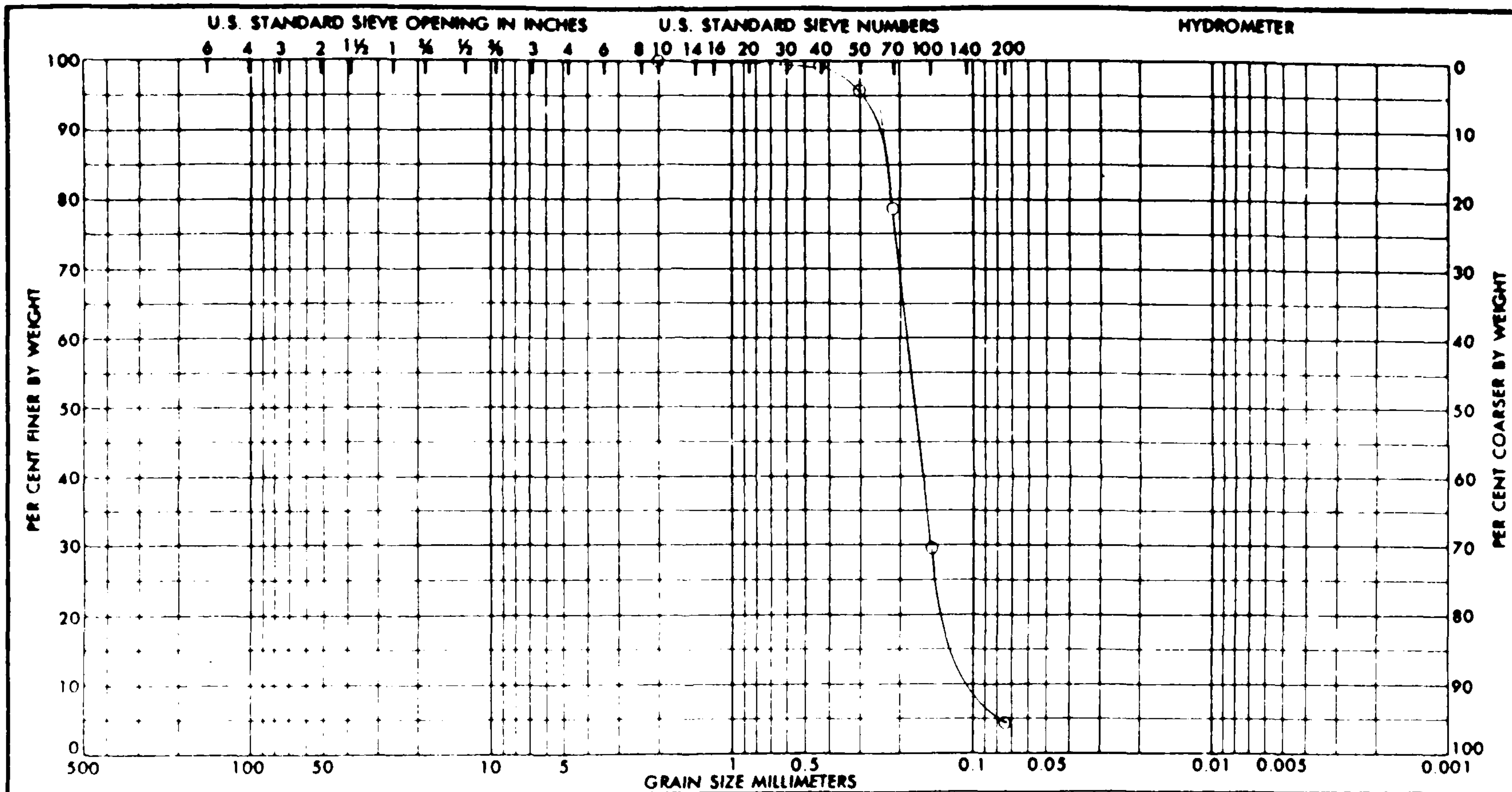


COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
7/3Y79	270'-295'	SAND (SP)		VISUAL		

PROJECT CHASKA FLOOD CONTROL

AREA

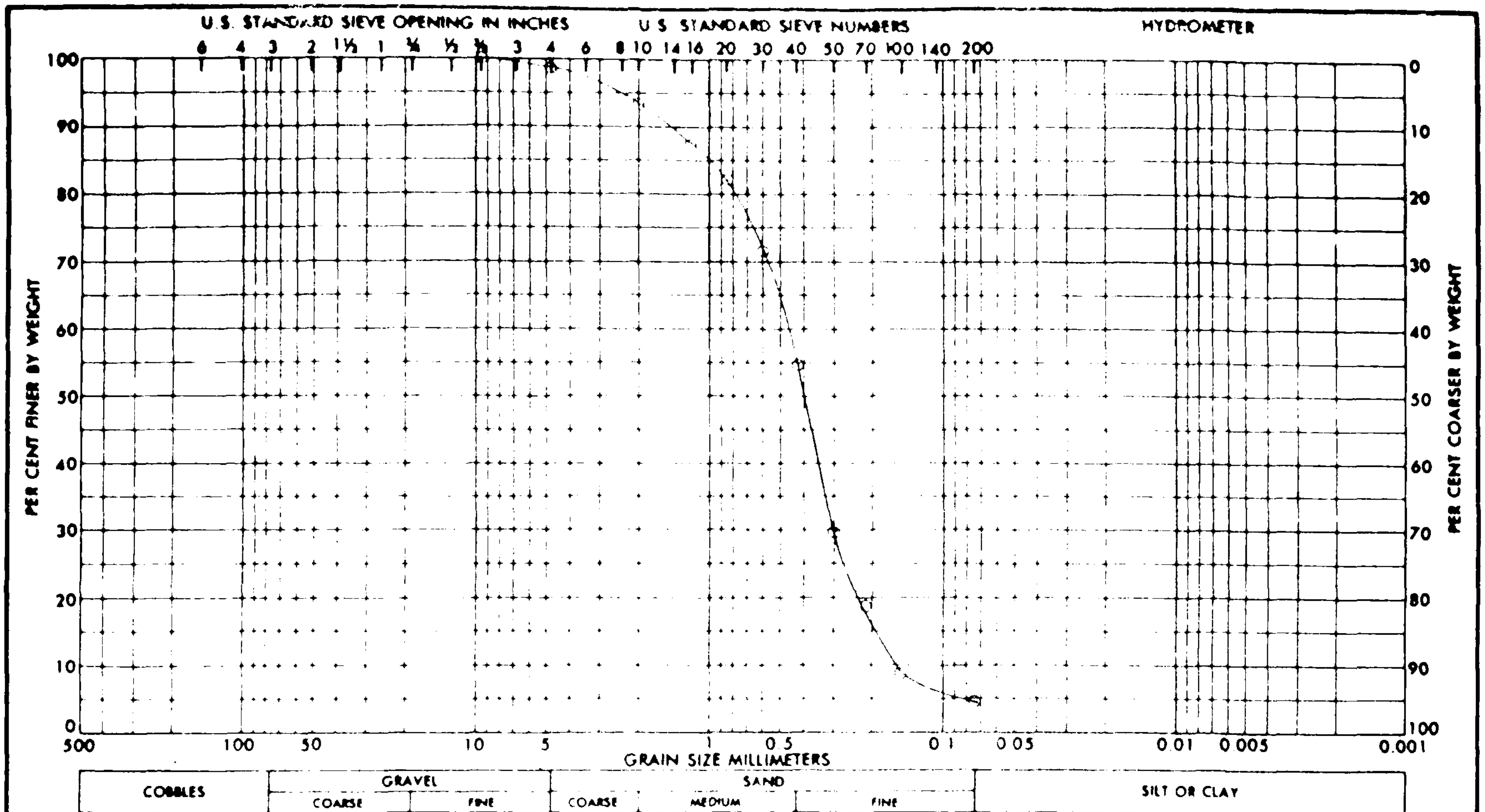
BORING NO 73-6M.

DATE MAY. 73

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO 1241, SEP 1962 WHICH IS OBSOLETE

U.S. GOVERNMENT PRINTING OFFICE 1963 OF - 700-124



SAMPLE NO	~~ELEV~~ OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
9/3Y 80	37.0'-39.5'	SAND (SP)		VISUAL		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-6M

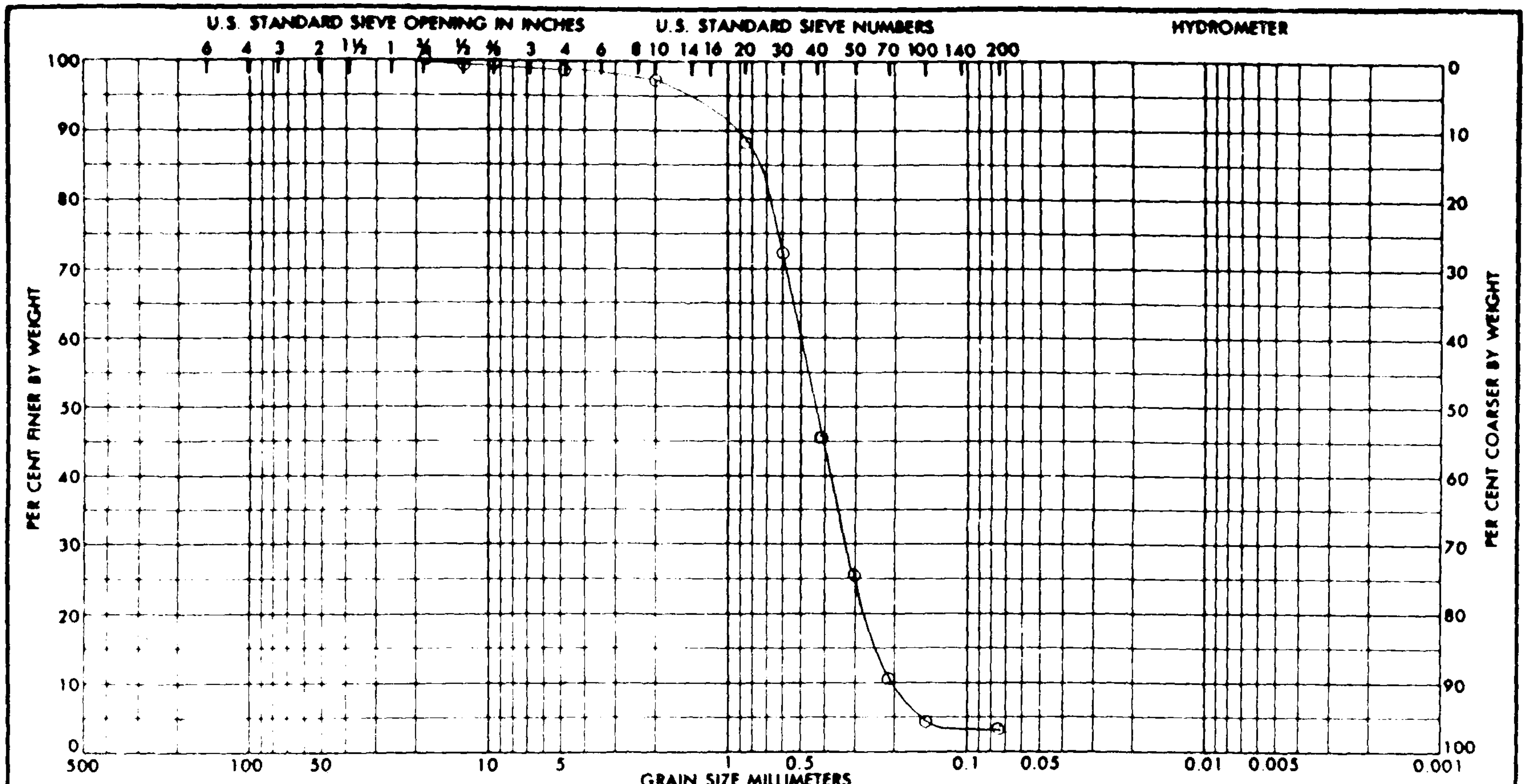
DATE MAY '73

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO 1241, SEP 1962 WHICH IS OBSOLETE

U.S. GOVERNMENT PRINTING OFFICE 1963 O - 700-120



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3/3Y82	9.5'-12.0'	SAND (SP)		Visual		

PROJECT CHASKA FLOOD CONTROL

AREA

BORING NO 73-8M

DATE MAY, '76

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO 1241, SEP 1962 WHICH IS OBSOLETE

DESIGN & COST ESTIMATES

APPENDIX 6

LIMITED REEVALUATION REPORT

MINNESOTA RIVER AT CHASKA, MINNESOTA

PREPARED BY THE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

APPENDIX 6

DETAILED ESTIMATE OF FIRST COST
(October 1981 Price Levels)

SELECTED PLAN 8

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL ESTIMATED COST
FEDERAL FIRST COST				
Relocations				
Railroads				
Construct bridge (2)	Job	Sum	--	$157,000
Remove abandoned bridge (2)	Job	Sum	--	10,000
Contingencies				22,000
TOTAL RAILROADS				189,000
TOTAL RELOCATIONS				189,000
Fish and Wildlife Facilities (Chaska Lake moist soil unit with Chaska Lake control structure)				
Levee fill and compaction	CY	10,320	$2.00	20,640
Seeding	Ac	3.7	1,000.00	3,700
Gravel	CY	310	11.00	3,410
Excavation	CY	370	3.00	1,110
Riprap	CY	6	20.00	120
Control structure 1	Job	Sum	-	5,700
Control structure 2	Job	Sum	-	5,700
Control structure 3	Job	Sum	-	6,820
Pumping pad	Job	Sum	-	1,264
Pump (portable)	Job	Sum	-	4,000
Tractor	Job	Sum	-	40,000
Chaska Lake outlet structure	Job	Sum	-	10,000
Contingencies				22,536
TOTAL FISH AND WILDLIFE FACILITIES				125,000
Channels				
Chaska Creek Diversion				
Excavation	CY	138,000	1.60	220,800
Riprap	CY	12,000	24.00	288,000
Bedding	CY	6,000	14.00	84,000
Drop Structure Sta. 11+50	Job	Sum	--	198,000
Drop Structure Sta. 35+00	Job	Sum	--	210,000
Drop Structure Sta. 58+00	Job	Sum	--	286,000
Concrete Channel	LF	1480	1900.00	2,812,000
Contingencies				509,000
TOTAL CHASKA CREEK				4,608,800

DETAILED ESTIMATE OF FIRST COST
(October 1981 price levels)

SELECTED PLAN 8

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL ESTIMATED COST
FEDERAL FIRST COST				
East Creek Diversion				
Levee Fill	CY	142,000	1.60	227,200
Excavation	CY	28,000	1.00	28,000
Riprap	CY	13,200	24.00	316,800
Bedding	CY	8,800	14.00	123,200
Drop Structure Sta. 3+00	Job	Sum	--	598,000
Drop Structure Sta. 26+60	Job	Sum	--	371,000
Drop Structure Sta. 36+00	Job	Sum	--	840,000
Drop Structure Sta. 48+60	Job	Sum	--	254,000
Stilling Basin Sta. 10+60	Job	Sum	--	224,000
16' Diameter tunnel	LF	1400	975.00	1,365,000
Contingencies				542,000
TOTAL EAST CREEK DIVERSION				4,888,200
TOTAL CHANNELS				9,497,000
Levees				
Levee Work				
Fill	CY	310,000	1.00	265,000
Sand berm	CY	11,000	6.00	66,000
Stripping	SY	136,000	1.60	217,600
Remove existing culverts	Job	Sum	--	17,000
Inspection trench	CY	20,800	3.00	62,400
Riprap	CY	7,580	30.00	227,400
Filter	CY	3,790	16.00	60,640
Landscaping	Job	Sum	--	80,000
Topsoil	CY	10,360	4.00	41,440
Seeding	acre	19.3	1000.00	19,300
Contingencies				131,200
TOTAL LEVEE WORK				1,188,000
Closures				
No. 1 (stoplog closure with peet-pile seepage barrier on abandoned Milwaukee RR)	Job	Sum	--	53,000
No. 2 (sandbag closure on Hwy 41)	Job	Sum	--	3,000
No. 3 (sandbag closure on First Street)	Job	Sum	--	3,000
No. 4 (seepage barrier Mpls. & St. Louis RR)	Job	Sum	--	4,000
Contingencies				6,000
TOTAL CLOSURES				69,000

DETAILED ESTIMATE OF FIRST COST
(October 1981 price levels)
SELECTED PLAN 8

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL ESTIMATED COST
FEDERAL FIRST COST				
Levees				
Drainage Facilities				
Reinforced Concrete Pipe:				
66" I	LF	620	134.00	83,080
72" I	LF	400	148.00	59,200
78" I	LF	350	160.00	56,000
84" I	LF	465	175.00	81,375
54" I	LF	250	110.00	27,500
24" V (Jacked)	LF	250	175.00	43,750
78" I	LF	390	160.00	62,400
84" I	LF	410	175.00	71,750
66" I	LF	400	134.00	53,600
84" V (through levee)	LF	480	175.00	84,000
Triple 108" 5000 D	LF	112	945.00	105,840
Triple 108" V	LF	216	795.00	171,720
30" IV	LF	66	50.00	3,300
30" M.D. Flapgate	Ea	1	300.00	300
66" (Jacked RR)	LF	30	430.00	12,900
66" (Levee) V	LF	60	200.00	12,000
Gatewell 66"	Job	Sum	--	18,000
Gatewell 84"	Ea	2	52,000	104,000
Gatewell Triple	Job	Sum	--	106,000
Sluice Gates:				
66"	Ea	1	18,000	18,000
84"	Ea	2	23,000	46,000
108"	Ea	3	40,000	120,000
Fill (Court House Lake containment levee)	CY	10,000	1.00	10,000
Inlets:				
Cast in place	Ea	6	5,000	30,000
Standard	Ea	12	2,000	24,000
Contingencies				174,700
TOTAL DRAINAGE FACILITIES				1,579,285
Relief Well System	Job	Sum		205,000
Contingencies				25,000
TOTAL RELIEF WELLS				230,000
TOTAL LEVEE UPGRADE				3,066,000

DETAILED ESTIMATE OF FIRST COST
(October 1981 price levels)

SELECTED PLAN 8

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL ESTIMATED COST
FEDERAL FIRST COST				
Pumping Plants				
Pump Station (6000 GPM)	Job	Sum	--	200,000
Discharge lines (3 Ea)				
16" diameter	LF	150	120.00	18,000
Contingencies				27,000
TOTAL PUMPING PLANTS				245,000
TOTAL CONSTRUCTION COST				13,122,000
TOTAL ENGINEERING AND DESIGN				1,729,000
TOTAL SUPERVISION AND ADMINISTRATION				916,000
TOTAL FEDERAL RECREATION FACILITY COST				33,000
TOTAL FEDERAL FIRST COST				15,800,000

DETAILED ESTIMATE OF FIRST COST
(October 1981 price levels)
SELECTED PLAN 8

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL ESTIMATED COST
NON-FEDERAL FIRST COST				
Lands and Damages				
Lands and Rights of Way Cost				1,224,000
Administrative Costs				87,000
Contingency				324,000
TOTAL LANDS AND DAMAGES				1,635,000
Relocations				
Bridge Removal				
Remove culvert on Hwy. 41 (1)	Job	Sum	--	44,000
Remove Brandondale Bridge (1)	Job	Sum	--	4,000
Remove First Street Bridge (2)	Job	Sum	--	10,000
Remove Hwy 212 Bridge (2)	Job	Sum	--	10,000
Contingencies				10,000
TOTAL BRIDGE REMOVAL				78,000
Bridge Modifications				
Construct Hwy 41 bridge (4)	Job	Sum	--	310,000
Construct County 17 bridge (1)	Job	Sum	--	107,000
Construct First Street bridge (2)	Job	Sum	--	71,000
Construct Hickory Street bridge (2)	Job	Sum	--	89,000
Construct Hwy 212 bridge (2)	Job	Sum	--	265,000
Engineering and contingencies				220,000
TOTAL BRIDGE MODIFICATIONS				962,000
Utilities				
Sanitary Sewer Force Main Relocation (1)	Job	Sum	--	10,000
Sanitary Sewer Siphon (1)	Job	Sum	--	20,000
Sanitary Sewer Siphon (2)	Job	Sum	--	14,000
Relocate buried telephone cable (1)	Job	Sum	--	6,000
Construct 12-inch water main crossing (1)	Job	Sum	--	14,000
Relocate Brandondale utility conduit (1)	Job	Sum	--	20,000
Construct 6-inch water main bridge crossing (2)	LF	100	80.00	8,000
Relocate utility poles (2)	Job	Sum	--	14,000
Install 8-inch VCP sewer section 1 (3)	LF	2200	11.00	24,200
Install manholes section 1 (3)	Ea	5	1600.	8,000
Install 8-inch CIP force main (3)	LF	1400	21.00	29,400
Install 8-inch CI gate valve (3)	Ea	1	700.	700
Relocate hydrant (3)	Ea	1	2000.	2,000
Relocate utility lines (3)	Job	Sum	--	10,000
Engineering and contingencies				41,700
TOTAL UTILITIES				222,000

DETAILED ESTIMATE OF FIRST COST
(October 1981 price levels)
SELECTED PLAN 8

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL ESTIMATED COST
TOTAL RELOCATIONS				[illegible]
NON-FEDERAL SHARE OF RECREATION COSTS				[illegible]
TOTAL NON-FEDERAL FIRST COSTS				[illegible]
TOTAL FIRST COST				
Federal First Cost				[illegible]
Non-Federal First Cost				2,450,[illegible]
TOTAL FIRST COSTS				18,[illegible]30,000

(1) East Creek diversion channel/tunnel

(2) Chaska Creek diversion

(3) Minnesota River levee

(4) New bridge to replace Highway 41 embankment crossing of East Creek is less costly than other alternatives. (Strengthening embankment, increasing size of diversion to handle flood wave of embankment failure.)

RECREATION

LIMITED REEVALUATION REPORT

MINNESOTA RIVER AT CHASKA, MINNESOTA

APPENDIX 7

PREPARED BY THE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

TABLE OF CONTENTS

TABLES

PLATES

APPENDIX 7

INTRODUCTION

AUTHORITY

Recreation features proposed are specifically authorized by Public Law 94-587 in accordance with House Document 94-644 (Chief's Report, dated 12 May 1976).

The general authority to study recreation resources at Corps of Engineers projects is contained in the Federal Water Project Recreation Act of 1965 (P.L. 89-72), as amended. This act established recreation development policy at Federal water resource projects as a full project purpose to be addressed in all phases of study. Section 2(a) specifies that benefits for recreation should be included in the economics of a contemplated project, provided that non-Federal public entities agree (provide a Letter of Intent) to participate in the recreation development.

Special recreation facility considerations, such as trails, are covered under engineering guidelines described in Engineering Regulation 1165-2-1. The special facility section of this regulation states that "Project planning shall consider the incorporation of trails for nature study, hiking, self-propelled bicycle, horseback riding, snowshoe, cross-country ski, and access by fishermen and hunters. When practical, such trails are located to tie into existing hiking trails and metropolitan bicycle trails."

PURPOSE OF THE STUDY

The present study is to review the 1973 feasibility report for flood control at Chaska, Minnesota, and apply current planning criteria and study area information. The reason for this review is to determine if any changes have occurred since the congressional review in 1976 which would affect the authorized plan.

SCOPE OF THE STUDY

This study is a reanalysis of those factors which can be expected to affect existing and future participation rates for trail-associated activities. Factors to be examined in this study will include but not be limited to:

1. Changes in demographic data.

2. Development of competing facilities within the project influence area.

3. National and regional recreation participation trends.

In addition, the study will discuss whether additional development of recreation facilities is appropriate and economically justified.

BACKGROUND

In 1977 a feasibility report on flood control at Chaska concluded that a combined levee trail system was a desirable and economically justified development. To comply with the requirements for local cooperation in the development of recreation facilities, the city of Chaska furnished the Corps with a resolution documenting its intent to participate in the cost-sharing agreements as defined in the 1973 feasibility report. The U.S. Department of the Interior - Bureau of Outdoor Recreation (later the Heritage Conservation and Recreation Service) and the county of Carver supported the combined levee trail development. The Bureau of Outdoor Recreation especially noted that linkage with the Minnesota River Valley Trail, which will extend from Fort Snelling to Le Sueur, was highly desirable. In 1976 Congress authorized the recommended plan for construction.

BASIC ASSUMPTIONS

It is assumed in this report that the climate, topography, geology, accessibility, and biologic and ecologic features in the area have remained for the most part unchanged. Local attractions have, however, changed since the bankruptcy of the Jonathan Development Corporation and the subsequent scaling down of the New Town Development by the Department of Housing and Urban Development. The impacts of this change will be considered in greater detail later in the report. Flood control project data are expected to remain substantially unchanged.

RECREATION MARKET AREA

RECREATIONAL ZONE OF INFLUENCE

The area surrounding the project that can be expected to contribute 80 percent of estimated visitation is called the zone of influence. In the 1973 feasibility report it was assumed that demand would essentially come from only the Chaska-Jonathan area. Some additional visitation is expected to result from the proximity of the Minnesota Valley State Trail, which is planned to connect with the proposed flood control levee.

There is no reason to believe that the previous assumption is inaccurate at this time. There are numerous existing and proposed regional parks and park reserves well distributed within the metro region that offer residents an assortment of specialized recreation activities and facilities. There is nothing unique about the project site to induce any significant displacement of regional demand to Chaska. No attempt has been made to determine what portion of the Minnesota Valley State Trail use should be claimed in the benefit analysis.

Proposed pedestrian greenways along East Creek will serve to connect the proposed trail with a number of recreation elements within the influence area that now function separately (see Plate 3):

a. Hennepin County Park Reserve at Carver, Minnesota.

b. University of Minnesota Arboretum.

c. Jonathan Area.

d. Minnesota River Valley Trail and National Wildlife Refuge.

e. Twin Cities Metro Council Regional Recreation Open Space System Plan.

f. Winkel Memorial Park and the Chaska Athletic Field.

In this light the levee trail system takes on a regional recreation significance as well as local.

SOCIOECONOMIC CHARACTERISTICS OF THE MARKET AREA

The current and projected population within the Chaska-Jonathan zone of influence has changed since the 1973 feasibility analysis, due to the bankruptcy of the Jonathan Development Corporation. Current and projected population within the zone of influence is shown in the following table.

Current and projected populations

Year	Population (1)
1980	8,400
1985	12,000
1990	15,500
1995	19,000
2000	22,500
2030	40,500

(1) Population estimates were obtained from the Twin Cities Metropolitan Council up to year 2000. An extrapolated estimate was made by the St. Paul District Economics Section for the year 2030.

LEISURE TIME ANALYSIS

The Third Nationwide Outdoor Recreation Plan published by the U.S. Department of the Interior - Heritage Conservation and Recreation Service (HCRS) in 1979 provides a good indication of expected trends in participation rates. Key factors which are affecting current activity patterns and should be considered in all local recreation project analyses are:

a. Changes in the population's age structure resulting from the "baby boom" and subsequent "baby bust."

b. Changes in traditional male-female roles and the consequent impact upon the recreation market.

c. The continued rise in real income and the resulting increase in the proportion available for recreation.

d. The effects of increased leisure time available to the labor force with the advance of congressionally mandated Monday holidays and policies such as flex-time.

In general, it is reasonable to assume that recreation participation rates will continue to grow in the foreseeable future. However, it is important that recreation developers also consider the impacts of energy constraints in their analysis. Recent studies indicated that people are traveling shorter distances but spending longer periods of time at their destination. Thus, recreation facilities closer to home are currently experiencing heavier use than in the past. It should be noted, however, that more time is needed to observe energy impacts on participation rates before trend conclusions can be made.

REGIONAL RECREATION DEMAND/NEEDS ANALYSIS

The 1979 Minnesota State Comprehensive Outdoor Recreation Plan (SCORP) has identified a number of recreation activities that should be expanded within the seven-county metro region, which includes Chaska. The planning staff recommended that recreation providers concentrate on developing opportunities for cross-country skiing, bicycling, tennis, fishing, boating, golf, swimming, and hiking.

Their surveys of more than 20,000 Minnesota households indicated that cross-country skiing was the most requested winter activity in region 11 (metro region). Hunting, snowmobiling, and ice skating followed cross-country skiing in popularity. Bicycling was a strongly requested summer recreation activity; in fact, it was the only activity requested for expansion by more than 20 percent of the people polled. Camping, tennis, and fishing opportunities were also requested. The activities listed in the SCORP as being requested by people in region 11 are shown in the following table.

Recreation activities

Winter activities	Summer activities	
Cross-country skiing	Bicycling	Horseback riding
Hunting	Camping	Backpacking
Snowmobiling	Tennis	Walking
Ice skating	Fishing	Baseball/softball
Miscellaneous skiing	Swimming	Jogging
Downhill skiing	Hiking	Archery
Target shooting	Golfing	Soccer
Ice fishing	Picnicking	Historic site visit
Trapping	Boating	RV uses
Sledding	Park facilities	Water skiing
Snow tubing	Canoeing	Bird watching
Snowshoeing	Trail biking	

Of special note within the metro region is the development of the Minnesota Valley National Wildlife Refuge and Recreation Area. The wildlife refuge is made up of numerous land units located along the Minnesota River from Ft. Snelling in Minneapolis upriver to Le Sueur. The land units will become a part of the National Wildlife Refuge System and will be owned and managed by the U.S. Fish and Wildlife Service (FWS). Besides managing the refuge for the benefit of wildlife resources, the FWS plans on having it provide compatible opportunities for observation, recreation, and environmental education. Connecting the various land units will be the Minnesota Valley Trail. The trail will provide recreationists an opportunity to travel nearly 75 miles along the Minnesota River, paralleling the historic trails of native Americans and early white settlers. Coordination with the State Planning Team responsible for the design and route selection has revealed a need and desirability to connect the Valley Trail with the proposed Corps levee at Chaska.

Nature interpretive centers within the seven-county metro region receive heavy use throughout the year. In 1978 the Carver Park Reserve had an attendance of approximately 45,000 persons. The University of Minnesota arboretum had well over 100,000 visitors. The proposed pedestrian greenways in Jonathan and Chaska will provide a means to link these two elements (see Plate 3).

It appears that the development of trail-related facilities in conjunction with the proposed levee, as proposed in the 1973 Feasibility Report, still has the greatest merit. The levee trail system would allow recreationists access to the Minnesota River Valley Trail System, giving the area regional, in addition to local, significance. At present there are limited opportunities for trail-related recreation activities within the immediate Chaska-Jonathan area.

DETERMINATION OF OUTDOOR RECREATIONAL ATTENDANCE

PER CAPITA PARTICIPATION RATES

The 1973 feasibility report identified six activities that were expected to constitute the majority of use at the project. Per capita participation rates were then taken from the West North Central Participation Rates, Bureau of Outdoor Recreation, 1969 (later the Heritage Conservation and Recreation Service). However, the recently prepared Minnesota SCORP provides new participation data that have been incorporated into a new calculation of participation rates.

Unlike the 1973 report, the phase I study included only two predominant activities in the recreation benefit calculations: recreation bicycling and nature walks. Numerous additional trail-related activities (e.g., cross-country skiing, snowmobiling, sledding) are also expected to occur. However, none of these activities will benefit substantially from the construction of an asphalt trail on top of the levee.

Participation rates for recreation bicycling and nature walks were obtained by comparing estimated and projected activity occasions originating in Region 11 (1979 SCORP) against population data (Metro Council to year 2000 - extrapolated to 2030) as shown in the next two tables.

Recreation bicycling

Year	Activity occasions	Population	Participation(1) rate
1978	23,421,808	1,792,781	13.06
1980	23,048,440	2,027,700	11.37
1985	22,886,541	2,121,500	10.79
1990	24,269,524	2,222,500	10.92
1995	25,194,655	2,300,500	10.95

(1) Obtained by dividing population into activity occasions.

Nature walks(1)

Year	Activity occasions	Population	Participation(2) rate
1978	1,455,388	1,792,781	0.81
1980	1,492,651	2,027,700	0.74
1985	1,572,002	2,121,500	0.74
1990	1,704,915	2,222,500	0.77
1995	1,818,440	2,300,500	0.79

(1) Listed as birdwatching/nature study in the Minnesota SCORP.
(2) Obtained by dividing population into activity occasions.

It is assumed that these participation rates based upon the Minnesota SCORP reflect the existing and future demand for expected trail use more accurately than the participation rates used in the 1973 feasibility report.

ESTIMATED ATTENDANCE AT PROJECT

The following two tables employ the metro region participation rates previously determined to calculate the total annual activity occasions within the zone of influence (Chaska-Jonathan).

Recreation bicycling within the zone of influence

Year	Population(1)	Participation rates(2)	Activity occasions (3)
1980	8,400	11.37	95,508
1985	12,000	10.79	129,480
1990	15,500	10.92	169,260
1995	19,000	10.95	208,050
2000	22,500	11.42 (4)	256,950
2030	40,500	11.42 (4)	462,510

(1) Metro Council to year 2000 (extrapolated to 2030).
(2) Calculated from Minnesota SCORP, 1979.
(3) Activity occasions = participation rate X population.
(4) Average participation rate calculated from Minnesota SCORP, 1979.

Nature walks within the zone of influence

Year	Population (1)	Participation rates (2)	Activity occasions (3)
1980	8,400	0.74	6,216
1985	12,000	0.74	8,880
1990	15,500	0.77	11,935
1995	19,000	0.79	15,009
2000	22,500	0.77 (4)	17,325
2030	40,500	0.77 (4)	31,185

(1) Metro Council to year 2000 (extrapolated to 2030).
(2) Calculated from Minnesota SCORP, 1979.
(3) Activity occasions = participation rate X population.
(4) Average participation rate.

Not all activity occasions can be attributed to the project, since not all projected activity occasions within the zone of influence would occur on the levee. Therefore, an adjustment was made in the following table. The "percentage of use" column reflects that percentage of the total activity occasions that could be expected to occur on the levee. Expected annual activity occasions for the project are then divided by 2.0 activities per day to convert to recreation days which can then be assigned a day-use value for calculation of benefits.

Adjusted activity occasions (with project)

Activity	Percentage of use (1)	Year 1980	1985	1990	1995	2000	2030
Recreation bicycling	10	9,551	12,948	16,926	20,805	25,695	46,251
Nature walks	75	4,662	6,660	8,951	11,257	12,994	23,389
Total		14,213	19,608	25,877	32,062	38,689	69,640
Recreation days (2)		7,106	9,804	12,938	16,031	19,344	34,820

(1) Based upon Chaska feasibility report, Corps of Engineers, August 1973.
(2) Recreation days = activity occasions/2.0 activities per day.

Calculation of benefits must also take into account those activity occasions already occurring without the proposed project. The existing levee, although unimproved, is assumed to be having some use. The percentage of use column is an estimate of current use as shown in the following table.

Adjusted activity occasions (without project)

Activity	Percentage of use(1)	1980	1985	1990	1995	2000	2030
Recreation bicycling	0	0	0	0	0	0	0
Nature walk	10	622	888	1,193	1,501	1,732	3,118
Total		622	888	1,193	1,501	1,732	3,118
Recreation days		311	444	596	750	866	1,559

(1) Based upon Chaska feasibility report, Corps of Engineers, August 1973.
(2) Recreation days = activity occasions/2.0 activities per day.

The net annual recreation benefit calculation will be the without project figure subtracted from the with project figure.

ANNUAL BENEFIT CALCULATION

A standard economic analysis and an interest rate of 7-3/8 percent were used to convert annual recreation days to average annual recreation benefits. In conjunction with the new NED benefit evaluation procedures for recreation (ER 1105-2-30, Federal Register, 14 December 1979), day use values were calculated, under the Guidelines for Assigning Points for General Recreation, at $1.90 with the proposed trail development and $1.25 under existing conditions. The following two tables show the annual recreation benefits, as calculated with this method, that could be expected with the proposed project and with the existing levee without the proposed project. Operation and maintenance costs were estimated to be $0.20 per visitor day for the proposed trail facilities. Net average annual discounted recreation benefits = $28,976.81 (with project) - $862.60 (without project) = $28,114.21.

Annual Recreation Benefits (With Project)

Name of Project - Chaska, Minnesota, Flood Control Project
Interest Rate - 0.07375
Economic Life - 50 years

Determination of Unit Value for General Recreation

Estimated Day-Use Value - $1.90

Annual Recreation Benefits (Using Straight Line Growth)

Year	Visitation	Annual Benefits
1980	7,106	$13,501.40
1985	9,804	18,627.60
1990	12,938	24,582.20
1995	16,031	30,458.90
2000	19,344	36,753.60
2030	34,820	66,158.00

Accumulated Discounted Total Benefits $381,708.22
Amortization Factor 0.075914
Average Annual Discounted Recreation Benefits $28,976.81
Average Annual Visitation 20,756.73

Annual Operation and Maintenance Costs

Average Annual Visitation 20,756.73
Projected O&M Per Visitor Cost $0.20
Average Project O&M Cost $4,151.345

Annual Recreation Benefits (Without Project)

Name of Project - Chaska, Minnesota, Flood Control Project
Interest Rate - 0.07375
Economic Life - 50 years

Determination of Unit Value for General Recreation

Estimated Day-Use Value - $1.25

Annual Recreation Benefits (Using Straight Line Growth)

Year	Visitation	Annual Benefits
198[illegible]	311	$ 388.75
1985	444	555.00
1990	596	745.00
1995	750	937.50
2000	866	1,082.50
2030	1,559	1,948.75

Accumulated Discounted Total Benefits $11,362.94
Amortization Factor 0.075914
Average Annual Discounted Recreation Benefits $862.60
Average Annual Visitation 934.19

Annual Operation and Maintenance Costs

Average Annual Visitation 934.19
Project O&M Per Visitor Cost $0.20
Average Project O&M Cost $186.837

In 1973 it was reported that Chaska was committed to preserving [illegible] space along Chaska and East Creeks and on the river side of the proposed flood control levee. A recent check with Chaska's city planner confirmed the city's intent to continue in this direction. Federal assistance [illegible] facilities along East Creek could be made available in the future. [illegible] Creek will be used as a low flow channel, thus making the additi[illegible] related.

RECOMMENDED PLAN OF DEVELOPMENT

PROPOSED DEVELOPMENT

The proposed project consists of a trail system along the top of the levee and beautification of the project by incorporating overburden areas and natural vegetation. Where riprap is not required for erosion, the levee should be seeded to native prairie grass species, which grow to a height of approximately 6 to 8 inches and require virtually no maintenance. Because burning would not be possible, only prairie species that can be established without burning would be used.

An 8-foot-wide asphalt path would be established along the top of the levee and would extend from the western edge of the Chaska levee to Courthouse Lake, and then continue around the lake in a short loop (Plate 7-1). The levee would continue past Courthouse Lake and tie into high ground a few hundred yards beyond. Plate 7-2 shows a detail of how the exiting levee will connect with the proposed levee, providing usable space for recreational activities. Chaska could easily maintain picnic grounds at Courthouse Lake as an area for passive recreational pursuits. An overburden area (as described in EM 1110-2-[illegible], 29 December 1972) is shown which would not affect the structural integrity of the levee, but would add to the attractiveness of the project in this area. By incorporating this overburden area, native floodplain vegetation would be allowed to grow up the sides of the levee and create a natural-appearing site conducive to birding, walking, and other activities.

Paving the trail would encourage bicycle traffic. It is hoped that by encouraging bicycle use of the levee trail, present congestion and conflict between automobiles and bicycles in Chaska would be somewhat alleviated. The trail would also encourage use and create a desirable flow pattern. Courthouse Lake would serve as a city park, and people could take lunches on their bicycle and ride to the park. Ample parking currently exists near the lake which would encourage people to drive there and then bicycle around the lake or to other portions of the area. The paved pathway around the lake would also encourage use by handicapped people, including those confined to wheelchairs.

[illegible]

[illegible] problem is undesirable forms of motorized recreation [illegible] It is incongruent to establish [illegible] the area and then permit machines to [illegible] the area. [illegible] to enjoy the area by hiking and bicycling [illegible] interruption by noisy, smelly machines is not acceptable. [illegible] would be expected to prohibit access [illegible] features are constructed.

[illegible] LOAD CRITERIA

The two predominant types of [illegible] trail would create an estimated [illegible] year 20[illegible]. This assumes maximum use [illegible] per visit. An estimate [illegible] mined as follows:

[illegible]. [illegible] annual activity [illegible] / 180 recreation-day season [illegible] per [illegible]

[illegible]. [illegible] activity occasion per [illegible] [illegible] per [illegible]

[illegible] activ[illegible]

[illegible]. [illegible] / [illegible] of peak use per weekend [illegible]

[illegible] the reported capacities of 60 to 1,[illegible] per [illegible], as shown in the "[illegible]ways Planning Criteria and Guidelines," School of Engineering, University of California at Los Angeles, April 19[illegible], the estimate of [illegible] people per hour for the proposed trail is an acceptable level of use.

[illegible] WILDLIFE [illegible] AND [illegible]

Fish and wildlife would be slightly and indirectly benefited by construction of the levee around Courthouse Lake. The lake has a "put and take" trout fishery. During floods it receives water and, with that, debris and undesirable rough fish from the Minnesota River. The proposed levee would eliminate flooding by protecting the lake, therefore preventing entrance of rough fish and debris.

[illegible] Sixty percent of the recreational use would occur on the weekend.

Assuming 50 percent of peak use would occur during [illegible] hours (i.e., 1 p.m. - [illegible] p.m. on weekend days).

[illegible]

The only vegetation program would be as mentioned above in "Proposed Development."

COORDINATION WITH OTHER AGENCIES

No additional formal coordination was done with other agencies in the preparation of this reaffirmation study because of the lack of any significant change from the development proposed in the 1973 feasibility report. Informal coordination has occurred with Chaska's Park and Recreation Director and the Minnesota Department of Natural Resources (DNR) regarding their recent opinion of the proposed development plan and its role in the planning of the Minnesota Valley Trail.

The general feeling concerning the project is positive. The Minnesota DNR is planning on making use of the proposed levee trail as a segment of the Minnesota Valley State Trail.

[illegible] PROBLEMS

No conflicts presently exist concerning the proposed levee trail system or any other agency programs. The trail would be paved and access points would have gentle grades so wheelchair patients, the elderly, and other persons with physical constraints [illegible] to enjoy the Courthouse Lake area. Ramps necessary for [illegible] to enter existing parking lots would be natural entrance points for wheelchairs.

[illegible]

The environmental [illegible] of the project will determine to a large degree its [illegible]. Extreme care in establishing prairie grass and overburden areas [illegible] for the project to appeal to the recreationist. The use of additional [illegible] sections along the levee would be extremely valuable in blending [illegible] into the surrounding vegetation. [illegible] how these sections may be utilized.

COSTS

The following table summarizes the estimated costs for recreation facilities.

Cost estimate, recreational trail along levee

Item	Unit	Quantity	Unit cost	Total cost
Paving on new levee	Job	Sum	--	[illegible],000
Paving on existing levee around Courthouse Lake	Job	Sum	--	[illegible],000
Landscape plants in overburden area	Job	Sum	--	[illegible]
Signs	Job	Sum	--	[illegible],000
Total construction cost				
Contingencies				[illegible],000
Engineering and Design				[illegible],000
Supervision and Administration				[illegible],000
Total Cost				[illegible],000

MANAGEMENT AND COST SHARING

[illegible]

[illegible] the Flood Control Act of 1944 (16 U.S.C. 460 d), as amended by [illegible] the Flood Control Act of 1962, grants general permissive authority to [illegible] recreational developments at all water resource developments. [illegible] which requires matching local participation in terms [illegible] will equal the Federal share. If the local interests [illegible] participating, no Federal recreational development [illegible] with the project.

[illegible]

[illegible] Article 3, Section (a), payment by the city may be immediately in cash, [illegible] in kind, or may be on an installment basis over a period not exceeding [illegible] years.

CONTRACT BETWEEN
THE UNITED STATES OF AMERICA
AND
THE CITY OF CHASKA, MINNESOTA
FOR
RECREATION DEVELOPMENT

THIS CONTRACT entered into this _____ day of ___________ 19 ___ by and between the UNITED STATES OF AMERICA (hereinafter called the "Government"), represented by the Contracting Officer executing this Contract and the City of Chaska, Minnesota (hereinafter called "City"), WITNESSETH THAT

WHEREAS, construction of the Chaska Flood Control Project (hereinafter called the "Project"), was authorized by the Flood Control Act of 1958, approved 3 July 1958 (Public Law 85-500, 85th Congress); and

WHEREAS, the City is authorized to administer project land and water areas for recreational purposes, and to operate, maintain, and replace facilities provided for such purposes, and is empowered to contract for such purposes, and is empowered to contract in these respects; and

WHEREAS, the Government is specifically authorized by Public Law 94-587 to construct, maintain, and operate public park and recreation facilities at Chaska in accordance with House Document 94-644 under the control of the Department of the Army, and to permit the construction, maintenance, and operation of such facilities by local interests; and

WHEREAS, the cost of constructing said facilities will be shared equally by the parties in accordance with the cost-sharing requirements of House Document 94-644, except that the City shall provide all lands without cost to the Government.

NOW, THEREFORE, the parties agree as follows:

ARTICLE 1 - DEFINITION OF TERMS. For the purpose of this Contract, certain terms are defined as follows:

(a) First costs, used interchangeably with the terms "capital cost" and "project costs", is the initial capital cost of the project, including engineering, design, supervision, and administration; land acquisition; construction; and interest during construction.

(b) Interest during construction consists of an amount of accrued interest computed on and added to expenditures for establishment of project services during the period between the actual outlay and the time the recreation [illegible] become available.

[illegible] LANDS AND FACILITIES.

[illegible] The Government agrees to design and construct the project to provide [illegible] enhancement of general recreation consistent with other authorized [illegible]. Details on lands necessary for such enhancement are shown [illegible] Land Requirements Plan - Public Use; Design Memorandum No. [illegible], [illegible].

(b) All recreation facilities proposed in the Plan of Recreation Development are to be located on land required for the Flood Control Project (i.e., facilities located only on project lands). The City shall provide these lands at no cost to the Government including the acquisition of rights therein for recreational purposes if such rights have not been previously acquired for the project and shall insure that these lands are available to the public for the life of the project. The City will operate and maintain these facilities and lands.

(c) The Government in cooperation with the City has prepared a mutually acceptable "Plan of Recreation Development" which depicts and identifies the types and quantities of facilities which the Government and the City will construct in accordance with this Contract (see Exhibit B). The presently estimated cost of facilities to be so provided is contained in Exhibit A, entitled "Estimated Project Costs Attributable to the Inclusion of Recreation Facilities", attached hereto and made a part hereof. Such estimate of facility cost is to be subject to an equitable adjustment as appropriate upon completion of construction in accordance with the above mentioned "Plan of Recreation Development".

(d) The facilities as depicted in Exhibit B, as it may be adjusted in accordance with paragraph (c) above, shall be constructed jointly by the parties on the basis of a mutually satisfactory division of responsibility for construction which takes into account direct and indirect cost savings which may be gained by the parties in the public interest for certain specific facilities; provided, that the facilities to be constructed by each party shall be formally agreed upon by the two parties prior to construction, consistent with the provisions of Article 3.

(e) Title to all project lands acquired by the City for flood control development upon which the aforementioned recreation development is to be constructed and any additional rights therein acquired for recreational purposes pursuant to Article 2(b) hereof shall at all times remain in the name of the City.

(f) The performance of any obligation or the expenditure of any funds by the Government under this contract is contingent upon Congress making the necessary appropriations and upon funds being allocated and made available for the work required hereunder.

ARTICLE 3 - CONSIDERATION AND PAYMENT. Each party hereto will pay or contribute in kind fifty percent (50%) of the separable first costs of recreation development contained in Exhibit B. The City shall receive credit against its fifty percent (50%) share for approved expenditures for separable lands required for recreational purposes.

(a) Initial Development. Fifty percent (50%) of the estimated separable first costs of initial recreation development is estimated to be $. Upon substantial completion of the initial development, the Contracting Officer shall compute the total expenditures by each party to such date. In computing expenditures, there shall be considered cash payments and contributions in facilities, at the fair market value thereof at the time such facilities are provided. If the total expenditures by the Government have exceeded those of the City, the City shall pay to the Government such sum as will equalize the expenditure of both parties. In addition, the City shall pay to the Government interest on such payment, computed at the rate established by the Secretary of the Treasury of the Government as of the beginning of the Government fiscal year in which project construction is initiated, pursuant to the formula prescribed by Section 301(b) of the Water Supply Act of 1958 (Public Law 85-500, 43 U.S.C. 390b(b)). For the project this interest rate is percent. Such interest shall be computed for the period between dates of the actual outlays by the Government and date of the City payment. Payment will be made within six (6) months after written notification to the City of Chaska by the undersigned Contracting Officer or his successor.

(b) Future Development. No future development is proposed under this Contract.

(c) Other Federal Funds. No repayment credit of any kind whatsoever will be allowed the City for expenditures financed by, involving, or consisting of, either in whole or in part, contributions or grants of assistance received from any Federal agency, in providing any lands or facilities for recreation enhancement hereunder.

(d) Adjustments to reflect costs. The dollar amounts set forth in this Article are based upon the Government's best estimates, and are subject to adjustments based on the costs actually incurred. Such estimates are not be be construed as representations of the total financial responsibilities of each of the parties.

ARTICLE 4 - CONSTRUCTION AND OPERATION OF ADDITIONAL FACILITIES. Certain types of facilities, including but not necessarily limited to vending machines, swimming pools, commissaries, and such similar revenue-producing facilities, may be constructed by the City or third parties and may be operated by the City or by third parties on a concession basis. Any such construction and operation of these types of facilities shall be compatible with all project purposes and shall be subject to the prior approval of the Contracting Officer. However, the City shall not receive credit for costs of such facilities against amounts due and payable under Article 3, and such facilities shall not be deemed to be developed or constructed with Government assistance for purpose of Article 2(e).

ARTICLE 5 - FEES AND CHARGES. The City may assess and collect fees for entrance to developed recreation areas and for use of the project facilities and areas, in accordance with a fee schedule mutually agreed to by the parties. Because the City has expressed that no fees will be collected for use of the proposed facilities, no fee schedule is attached. If the City decides to collect user fees in the future, a mutually acceptable fee schedule will be prepared and appended to this Contract. This schedule will be reviewed and updated not less frequently than every five (5) years for the life of the project.

ARTICLE 6 - FEDERAL AND STATE LAWS.

(a) In acting under its rights and obligations hereunder, the City agrees to comply with all applicable Federal and State laws and regulations, including but not limited to the provisions of the Davis-Bacon Act (40 U.S.C. 276 a-a 7); the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333); and Part 3 of Title 29, Code of Federal Regulations.

(b) The City furnishes, as part of this Contract, an assurance (Exhibit C) that it will comply with Title VI of the Civil Rights Act of 1964 (78 Stat. 241, 42 U.S.C. 2000d, et seq.) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations. The City agrees also that it will obtain such assurances from all of its concessionaires.

(c) The City agrees to comply with all provisions of Sections 210 and 305 of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646).

ARTICLE 7 - OPERATION AND MAINTENANCE. The City shall be responsible for operation, maintenance, and replacement without cost to the Government of all facilities developed to support project recreation opportunities. The City shall maintain all project lands, waters, and facilities in a manner satisfactory to the Contracting Officer and pursuant to the provisions of this Contract.

ARTICLE 8 - RELEASE OF CLAIMS.

(a) The Government and its officers and employees shall not be liable in any manner to the City for or on account of damage caused by the development, operation, and maintenance of the general recreation facilities of the project. The City hereby releases the Government and agrees to hold it free and harmless and to indemnify it from all damages, claims, or demands that may result from development, operation, and maintenance of the general recreation areas and facilities.

(b) The City shall require its concessionaires to obtain from an insurance company licensed in the State and acceptable to the Government, liability or indemnity insurance providing for minimum limits of $50,000.00 per person in any one claim, and an aggregate limit of $150,000.00 for any number of persons or claims arising from any one incident with respect to bodily injuries or death resulting therefrom, and $25,000.00 for damage to property suffered or alleged to have been suffered by any person or persons resulting from operations under any agreement between the City and its concessionaires.

ARTICLE 9 - TRANSFER OR ASSIGNMENT. The City shall not transfer or assign this Contract nor any rights acquired thereunder, nor grant any interest, privilege, or license whatsoever in connection with this Contract without the approval of the Secretary of the Army or his authorized representative except as provided in Article 4 of this Contract.

ARTICLE 10 - DEFAULT. In the event that the City fails to meet any of its obligations under this agreement, the Government may terminate the whole or any part of the Contract granted to the City for accomplishing the purpose of this agreement. The rights and remedies of the Government provided in this Article shall not be exclusive and are in addition to any other rights and remedies provided by law or under this Contract.

ARTICLE 11 - EXAMINATION OF RECORDS. The Government and the City shall maintain books, records, documents, and other evidence pertaining to costs and expenses incurred under this Contract, to the extent and in such detail as will properly reflect all net costs, direct and indirect, of labor, materials, equipment, supplies, and services and other costs and expenses of whatever nature involved therein. The Government and City shall make available at their offices at reasonable times, the accounting records for inspection and audit by an authorized representative of the parties to this Contract during the period this Contract is in effect.

ARTICLE 12 - RELATIONSHIP OF PARTIES. The parties to this Contract act in an independent capacity in the performance of their respective functions under this Contract and neither party is to be considered the officer, agent, or employee of the other.

ARTICLE 13 - INSPECTION. The Government shall at all times have the right to make inspections concerning the operation and maintenance of the lands and facilities to be provided hereunder.

ARTICLE 14 - OFFICIALS NOT TO BENEFIT. No member of or delegate to the Contress, or Resident Commissioner, shall be admitted to any share or part of this Contract, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this Contract if made with a corporation for its general benefit.

ARTICLE 15 - COVENANT AGAINST CONTINGENT FEES. The City warrants that no person or selling agency has been employed or retained to solicit or secure this Contract upon agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the City for the purposes of securing business. For breach or violation of the warranty, the Government shall have the right to annul this Contract without liability or in its discretion to add to the Contract price or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 16 - ENVIRONMENTAL QUALITY.

(a) In furtherance of the purpose and policy of the National Environmental Policy Act of 1969 (Public Law 91-190), 42 U.S.C. 4321, 4331-4335), Executive Order 11514, entitled "Protection and Enhancement of Environmental Quality," March 5, 1970 (35 Federal Register 4247, March 7, 1970); "The Endangered Species Acts of 1973"; and "Preservation of Historic and Archaeological Data Act of 1974" (88 Stat. 174), Public Law 93-291; the Government and the City recognize the importance of preservation and enhancement of the quality of the environment and the elimination of environmental pollution. Actions by either party will be after consideration of all possible effects upon the project environmental resources and will incorporate adequate and appropriate measures to insure that the quality of the environment will not be degraded or unfavorably altered.

(b) During construction and operation undertaken by either party, specific actions will be taken to control environmental pollution which could result from their activities and to comply with applicable Federal, State, and local laws and regulations concerning environmental pollution. Particular attention should be given to (1) reduction of air pollution by control of burning, [illegible] of [illegible], containment of chemical vapors, and control of [illegible] and smoke from temporary heaters; (2) reduction of water pollution [illegible] of [illegible] facilities, storage of fuels and other contaminants [illegible] turbidity and siltation from erosion; (3) minimization of [illegible] [illegible] and off-site disposal of waste and spoil activities, and [illegible] of landscape defacement and damage.

ARTICLE [illegible] - [illegible] OF FACILITIES OR LANDS OR INTERESTS THEREIN. If the [illegible] [illegible] agree on the fair market value of any facilities or lands or interests [illegible] and cannot otherwise resolve such differences, each party shall name an [illegible], and the two appraisers so named shall name a third appraiser, and the [illegible] of at least two of such three appraisers as to the fair market value shall be final and conclusive upon both parties.

[illegible] EFFECTIVE DATE. This Contract shall take effect upon approval [illegible] of the Army or his authorized representative.

IN WITNESS WHEREOF, the parties hereto have executed this Contract as of the day and year first above written.

THE UNITED STATES OF AMERICA

By: [illegible]
[illegible]
[illegible] of Engineers
[illegible]
[illegible]

THE CITY OF CHASKA, MINNESOTA

By: ____________________

APPROVED:

By: ____________________

Date: ____________________

CERTIFICATE OF AUTHORITY

I, ______________________________, do hereby certify that I am the City Attorney of the City of Chaska, Minnesota, that the City of Chaska is a legally constituted public body with full authority and capability to perform the terms of the agreement between the United States of America and the City of Chaska, Minnesota, in connection with the Recreation Development along the Minnesota River, Chaska, Minnesota, and to pay damages, if necessary, in the event of the failure to perform, and that the persons who have executed the Contract on behalf of the City of Chaska, Minnesota, have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this certificate this ______________ DAY of ____________________ A.D., 197__.

By: ______________________________
City Attorney

ESTIMATED PROJECT COSTS ATTRIBUTABLE TO THE
INCLUSION OF RECREATION FACILITIES

EXHIBIT A

RECREATION PLAN OF DEVELOPMENT

A recreation resource analysis demonstrated that there are specific needs for recreation facilities at the proposed Stage 4 Flood Control Project, Chaska, Minnesota.

In order to help satisfy expected recreation pressures, the facilities proposed include a developed pedestrian-bicycling trail on top of the levee, a picnic area, and landscape plantings.

EXHIBIT B

APPENDIX B

ASSURANCE OF COMPLIANCE WITH THE DEPARTMENT OF DEFENSE DIRECTIVE UNDER TITLE VI OF THE CIVIL RIGHTS ACT OF 1964

_____________________________ (hereinafter called "Applicant-Recipient")
(Name of Applicant-Recipient)

HEREBY AGREES THAT it will comply with title VI of the Civil Rights Act of 1964 (P.L. 88-352) and all requirements imposed by or pursuant to the Directive of the Department of Defense (32 CFR Part 300, issued as Department of Defense Directive 5500.11, December 28, 1964) issued pursuant to that title to the end that, in accordance with title VI of that Act and the Directive, no person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant-Recipient receives Federal financial assistance from _____________________ (Component of the Department) and HEREBY GIVES ASSURANCE THAT it will immediately take any measures necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Applicant-Recipient by this _____________________ (Component of the Department), assurance shall obligate the Applicant-Recipient or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant-Recipient for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the Applicant-Recipient for the period during which the Federal financial assistance is extended to it by _____________________ (Component of the Department).

EXHIBIT C

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts or other Federal financial assistance extended after the date hereof to the Applicant-Recipient by the Department, including installment payments after such date on account of arrangements for Federal financial assistance which were approved before such date. The Applicant-Recipient recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant-Recipient, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign this assurance on behalf of the Applicant-Recipient.

Dated ______________ ______________________

(Applicant-Recipient)

By ______________________

(President, Chairman of Board or comparable authorized official)

____

____

(Applicant-Recipient's Mailing Address)

EXHIBIT C (cont.)

The provisions and language contained in the stan[illegible] [illegible] (found in ECI A-311 of ER 1180-1-1) were modified [illegible] where necessary. Deviations from the standard format are explained below.

FIFTH PARAGRAPH

Lands to be used for the recreation development are project lands (i.e., they are required for the basic flood control project). Project lands must be provided by the non-federal sponsor. Therefore, the last line of the fifth paragraph, "except that the City shall provide all lands without cost to the Government.", was added.

ARTICLE 1

(a & c) Because this cost-sharing contract only involves one project purpose (i.e., recreation), all discussions of separable costs of all project purposes are not applicable.

(d) Because this contract involves no fish and wildlife development, mention of such services has been deleted. Discussion of interest during construction appears as Article 1 (b) of the attached contract.

ARTICLE 2

(a) Because the recreation development planned is associated with a l[illegible] flood protection project, the Government will not operate the project upon completion.

(b) All lands proposed for recreation development are project lands, and therefore no additional lands are needed. The clause added concerning maintenance of the lands for public availability was prompted by the 25 July 1978 review comments on the Lake Rebecca Cost-Sharing Contract.

(e) This paragraph is not applicable because there will be no lease of Federal lands for this project.

(f) (Shown as (e) on attached contract.) Lands being developed are project lands. Therefore, all titles to lands and/or easements will remain with the City, which acquired said lands for flood control purposes. Provisions for recreational use of easement lands is a responsibility of the City (i.e., must be specificially identified use of easement).

ARTICLE 3

(a) Because the lands associated with the recreation development are project lands, the City cannot receive credit toward the non-Federal share for the value of those lands.

(b) No future development is planned or proposed by the Plan of Development, and therefore these paragraphs are not applicable.

ARTICLE 4 - This article was changed to reflect the smaller scale of potential revenue-producing developments.

ARTICLE 5 - Changes were made because no user fees are anticipated. Therefore, no fee schedule is needed.

ARTICLE 7

(a) No lease or license is required by the non-Federal sponsor to maintain or operate the recreation development because the City has acquired control of subject recreation land via fee ownership and/or appropriate easement. Also, reference to (c) below is deleted because (c) is deleted.

(b) This paragraph is not applicable for a local flood protection project of the nature of the Chaska project due to the limited project lands and the location of these lands.

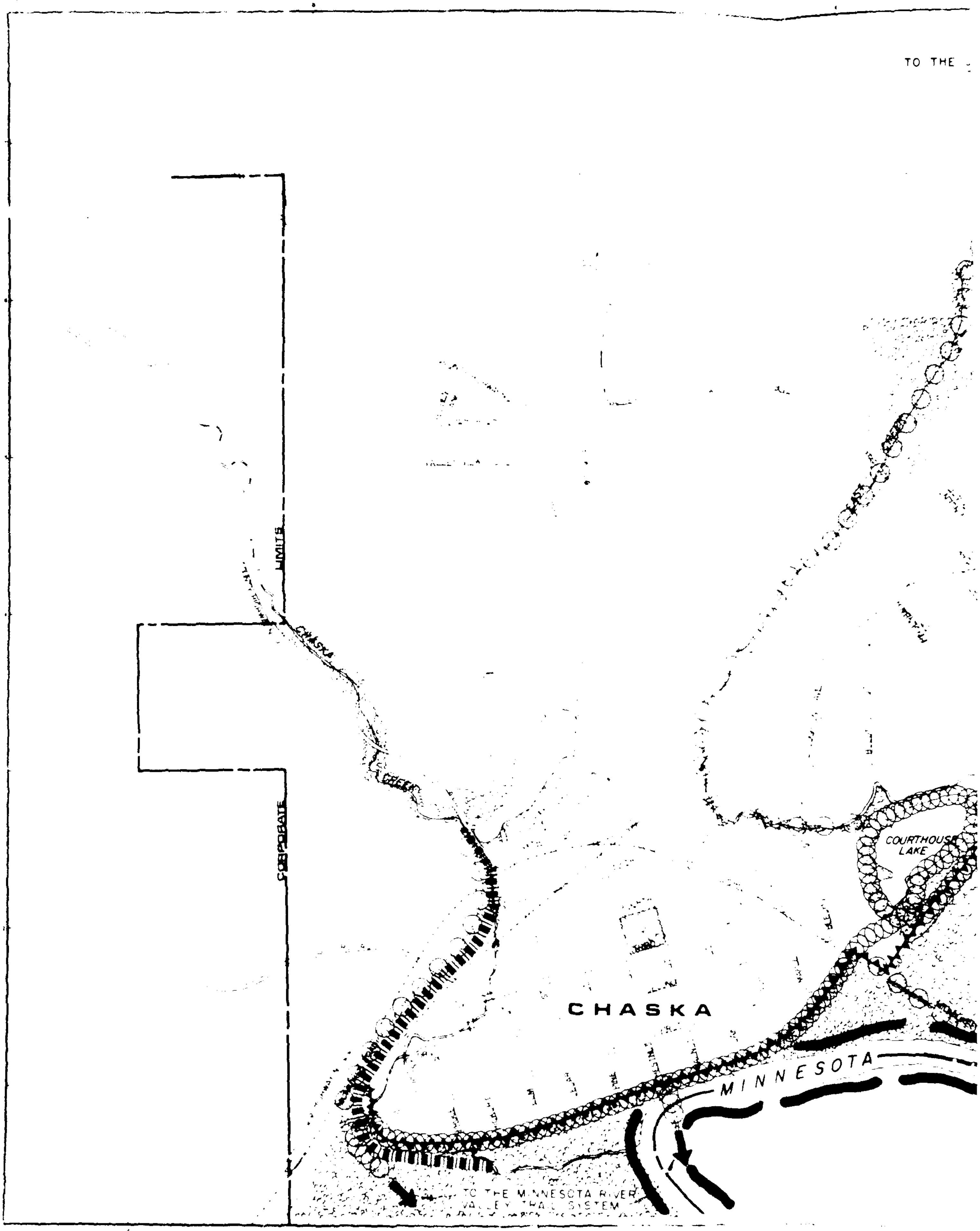
(c) This paragraph was intended for reservoir projects and is therefore not applicable to the Chaska recreational development project.

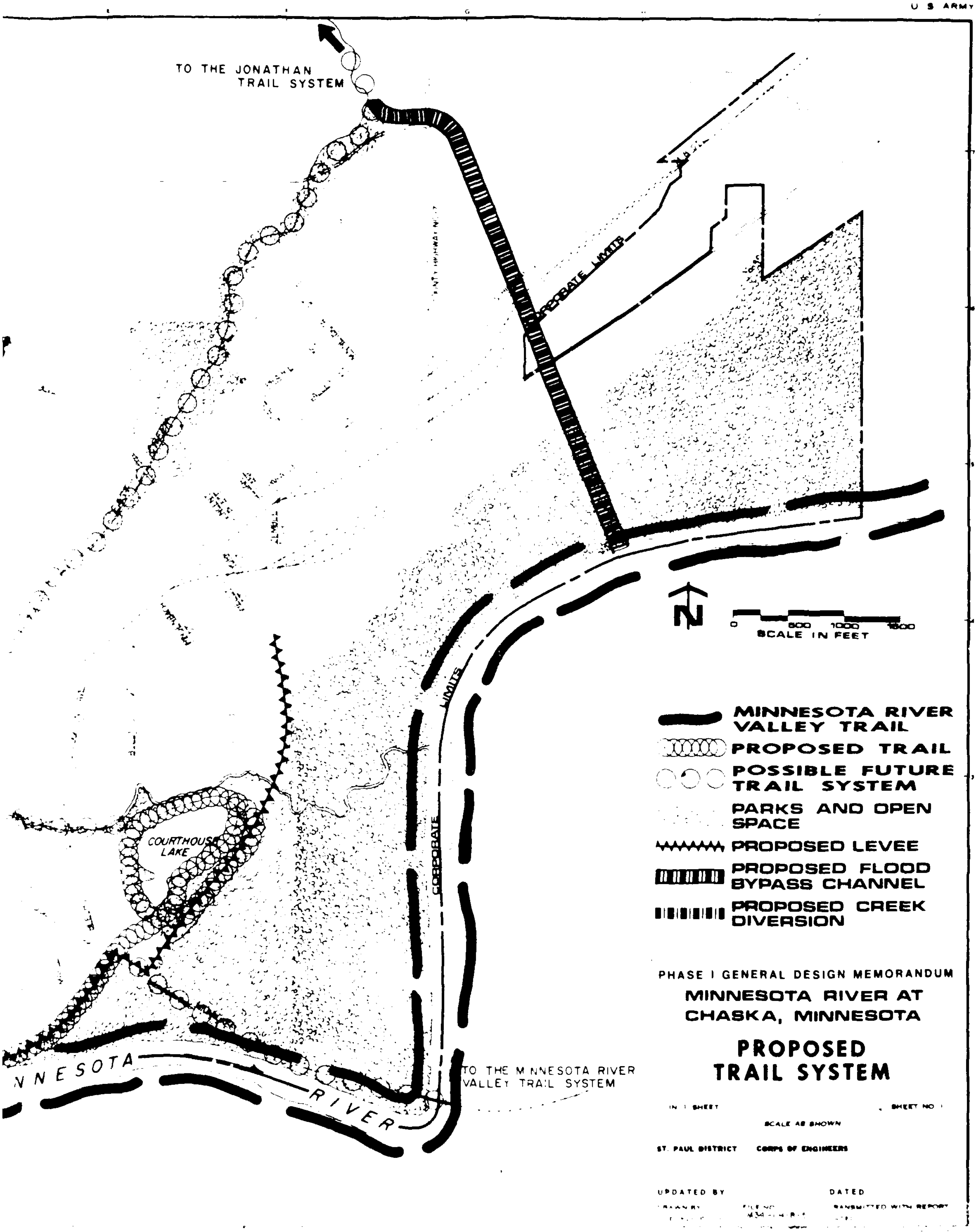
ARTICLE 8

(a) Fish and wildlife facilities are not included in this project.

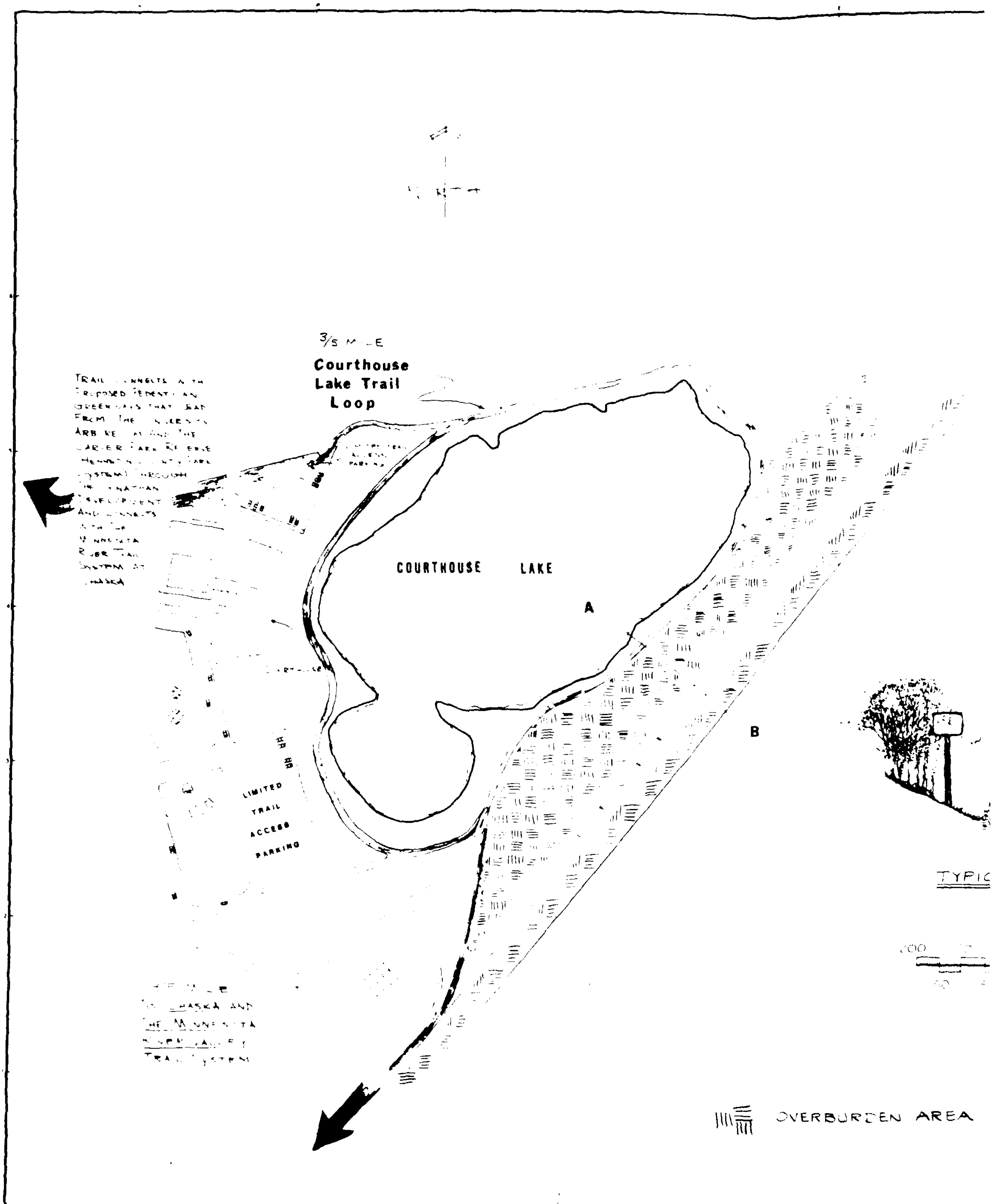
EXHIBIT C

The schedule of repayment is not attached because payments will not be made over time by the non-Federal sponsor. A lump sum payment will be made by the non-Federal sponsor to fulfill the cost-sharing commitment.


TO THE
LIMITS
CORPORATE
CHASKA
CREEK
EAST
CHASKA
COURTHOUSE LAKE
MINNESOTA
MINNESOTA
TO THE MINNESOTA RIVER VALLEY TRAIL SYSTEM



U S ARMY
TO THE JONATHAN TRAIL SYSTEM
CORPORATE LIMITS
COURTHOUSE LAKE
MINNESOTA RIVER
TO THE MINNESOTA RIVER VALLEY TRAIL SYSTEM
N
0 500 1000 1500
SCALE IN FEET
MINNESOTA RIVER VALLEY TRAIL
PROPOSED TRAIL
POSSIBLE FUTURE TRAIL SYSTEM
PARKS AND OPEN SPACE
PROPOSED LEVEE
PROPOSED FLOOD BYPASS CHANNEL
PROPOSED CREEK DIVERSION
PHASE I GENERAL DESIGN MEMORANDUM
MINNESOTA RIVER AT CHASKA, MINNESOTA
PROPOSED TRAIL SYSTEM
SCALE AS SHOWN
ST. PAUL DISTRICT CORPS OF ENGINEERS
UPDATED BY
DATED

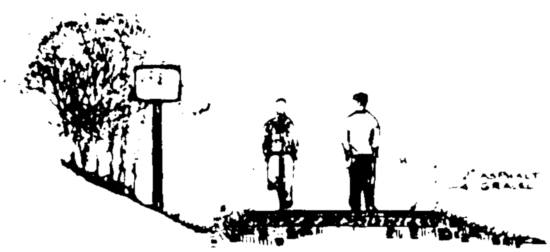

Courthouse Lake Trail Loop
COURTHOUSE LAKE
A
B
LIMITED TRAIL ACCESS PARKING
OVERBURDEN AREA

NOTE

The [illegible] Area [illegible] This Will Allow The Native [illegible] Vegetation [illegible] And Therefore [illegible] Will Eventually Establish A Native [illegible] Native Prairie Grasses Will Be [illegible]

CROSS SECTION

(NO SCALE)



TYPICAL 8' WIDE TRAIL

OVERBURDEN AREA

UPDATED BY: DATED:

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

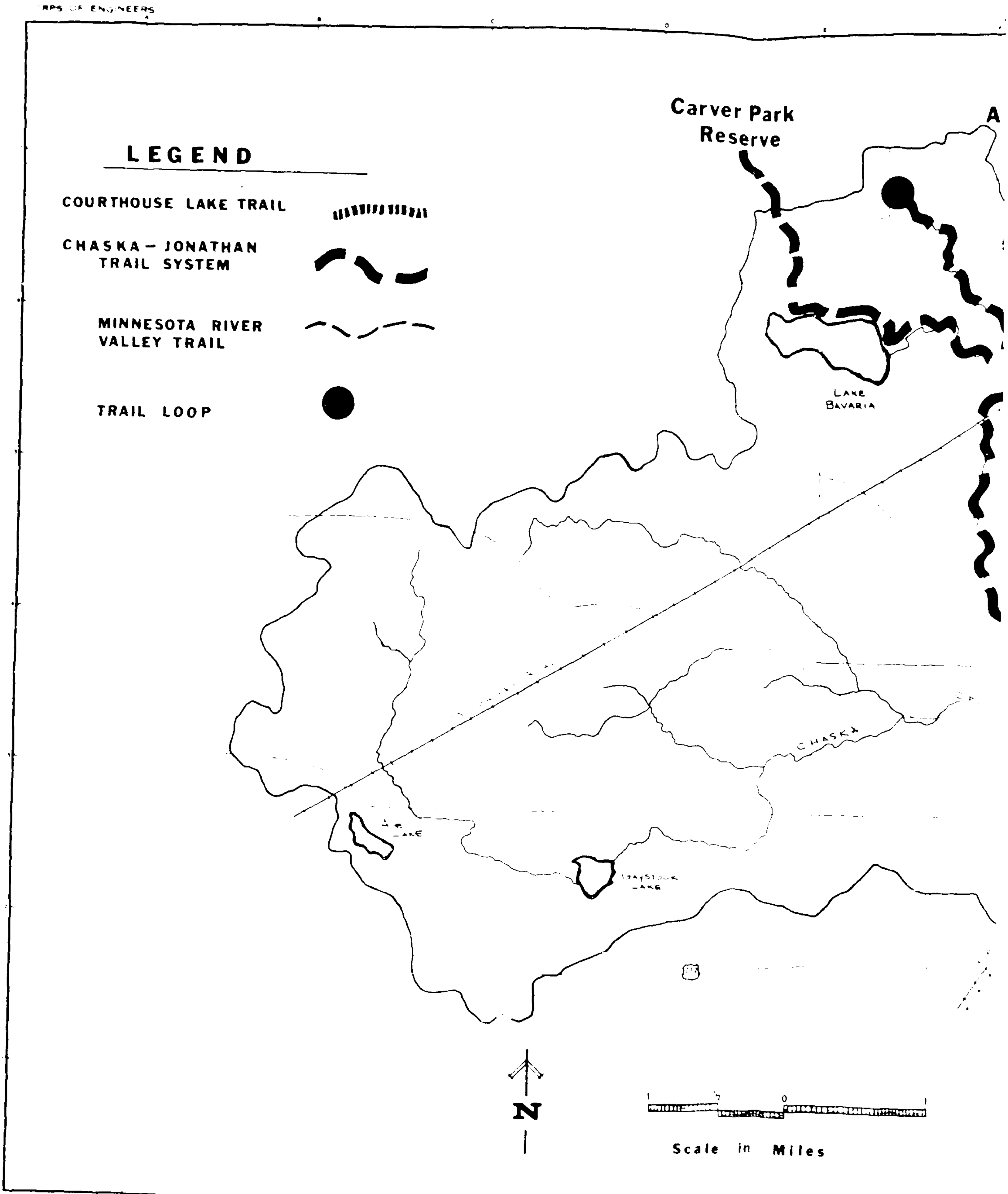
PHASE I GENERAL DESIGN MEMORANDUM
MINNESOTA RIVER AT
CHASKA, MINNESOTA

Courthouse Lake Trail

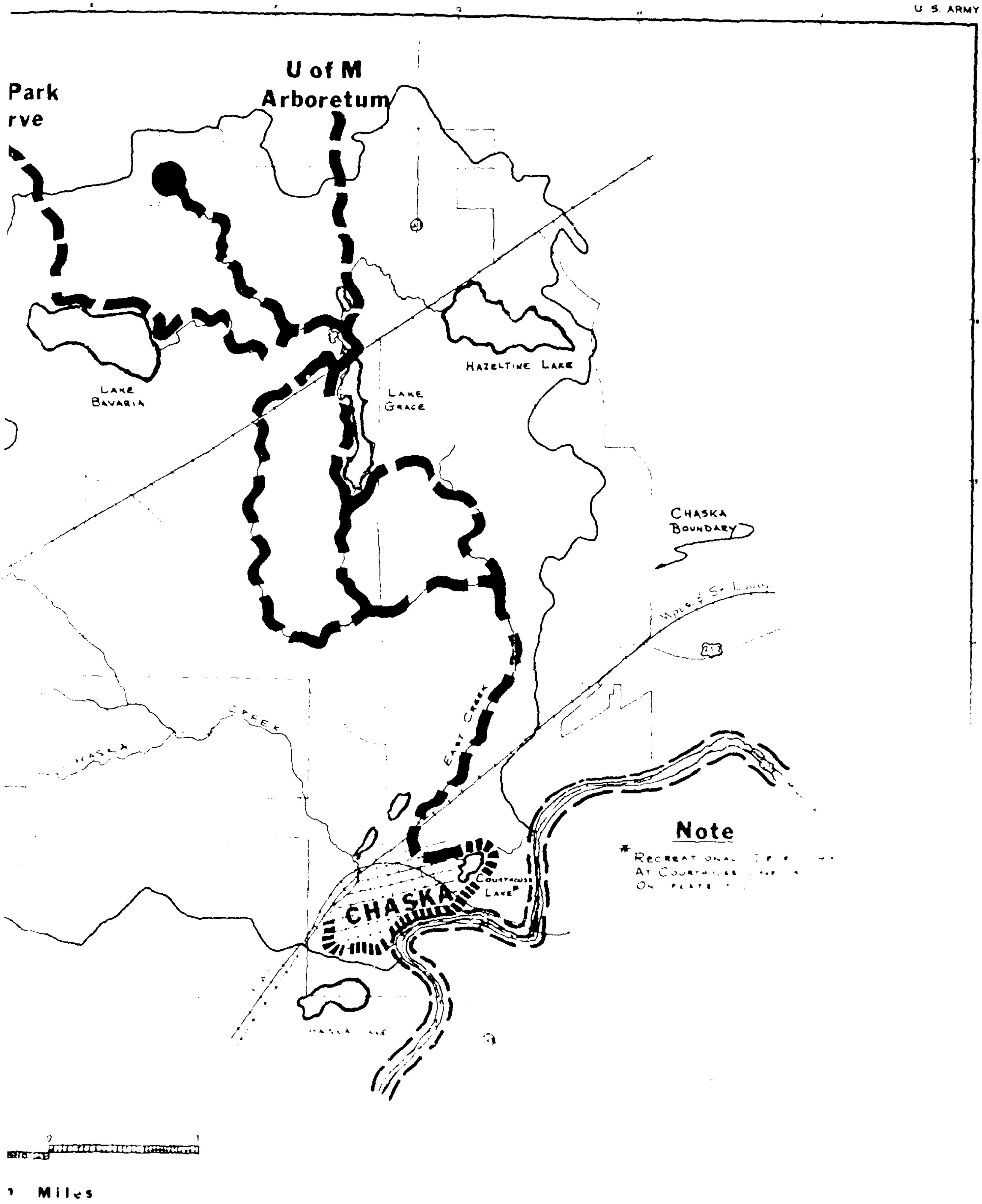
AS SHOWN

DRAWING NUMBER
M34-CH-R-5/12

PLATE 7-2

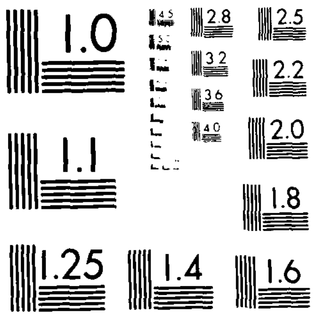


CORPS OF ENGINEERS
LEGEND
COURTHOUSE LAKE TRAIL
CHASKA – JONATHAN TRAIL SYSTEM
MINNESOTA RIVER VALLEY TRAIL
TRAIL LOOP
Carver Park Reserve
A
LAKE BAVARIA
CHASKA
N
Scale in Miles
1
½
0
1


Park
rve
U of M
Arboretum
Lake
Bavaria
Lake
Grace
Hazeltine Lake
Chaska
Boundary
East Creek
Creek
Chaska
Courthouse
Lake
Note
Miles

AD-A184 474 MINNESOTA RIVER AT CHASKA MINNESOTA TECHNICAL APENDIXES LIMITED REEVALUA..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT AUG 82 7/9

UNCLASSIFIED F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

WATER QUALITY

LIMITED REEVALUATION REPORT

MINNESOTA RIVER AT CHASKA, MINNESOTA

APPENDIX 8

PREPARED BY THE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

QUALITY OF SURFACE WATER BEFORE IMPLEMENTATION OF A FLOOD-CONTROL PROJECT IN CHASKA, MINNESOTA

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 82-__

Prepared in cooperation with the

U.S. ARMY CORPS OF ENGINEERS

QUALITY OF SURFACE WATER BEFORE IMPLEMENTATION OF A FLOOD-CONTROL PROJECT IN CHASKA, MINNESOTA

By L. H. Tornes

Quality of East and Chaska Creeks, and Courthouse Lake, and evaluation of probable changes in lake quality following construction

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U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 82-__

Prepared in cooperation with the

U.S. ARMY CORPS OF ENGINEERS

December 1981

UNITED STATES DEPARTMENT OF INTERIOR

JAMES G. WATT, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:

District Chief
U.S. Geological Survey
702 Post Office Building
St. Paul, Minnesota 55101

CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS

Multiply inch-pound units	By	To obtain SI (metric) units
inch (in)	25.40	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
acre	0.4047	hectare (ha)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
square mile (mi^2)	2.590	square kilometer (km^2)
acre-foot (acre-ft)	1233	cubic meter (m^3)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level."

QUALITY OF SURFACE WATER BEFORE IMPLEMENTATION OF A FLOOD-CONTROL PROJECT IN CHASKA, MINNESOTA

By L. H. Tornes

ABSTRACT

Samples were collected for 1 year from East Creek, Chaska Creek, and Courthouse Lake in Chaska, Minnesota, to determine the water quality before a flood-control project proposed by the U.S. Army Corps of Engineers is implemented.

The two creeks had similar water-quality characteristics. Data indicate that ground water may be the primary source of dissolved solids, sulfate, chloride, and chromium in the creeks. The pesticides alachlor, atrazine, simazine, and 2,4-D were found in water samples from both creeks but were well below the lethal concentrations for fish.

Courthouse Lake, a 57-foot deep stream-trout lake, had a mean summer trophic-state index of 35. Phytoplankton populations varied seasonally, and blue-green algae were predominant only in late summer. The algal-pollution index was highest in late summer, but did not provide evidence of high organic pollution.

The successful recovery of Courthouse Lake from past inundations by Minnesota River floodwaters having total phosphorus concentrations as high as 0.66 mg/L suggests that the lake, in time, will also recover from the added runoff expected as a result of implementing the flood-control project. The runoff could temporarily raise the total phosphorus concentration in the lake from 0.03 to 0.12 milligram per liter and raise the spring trophic-state index from 49 to 69.

INTRODUCTION

Chaska, in Carver County, Minn., southwest of the Twin Cities metropolitan area (fig. 1), is subject to periodic flooding from the Minnesota River. The U.S. Army Corps of Engineers, before implementing a project to reduce damage from floods, asked the U.S. Geological Survey to determine the water quality of East Creek, Chaska Creek, and Courthouse Lake in Chaska, which will be affected by implementing the proposed project. Data were collected from August 1979 through August 1980. This report describes the quality of the waters and the potential water-quality impacts of redesigning a levee that surrounds the city.

Hydrologic Setting

East and Chaska Creeks drain 11.7 and 14.8 square miles, respectively, along the northern bluff of the Minnesota River valley. The watersheds slope about 100 feet per mile and are underlain by till, outwash, and alluvium consisting of clay, silt, sand, and gravel. Courthouse Lake is in the Minnesota River flood plain and was formed when an abandoned clay-mining pit filled with water. It has been stocked with rainbow, brown, brook, and lake trout, splake, and coho salmon since 1967 and is the only designated

stream-trout lake in the seven-county metropolitan area (Minnesota Department of Natural Resources, written commun., 1980). The lake has a surface area of 11 acres and a maximum depth of 57 feet.

The mean annual precipitation in the Chaska area is 29 inches, which produces a mean annual runoff between 4.5 and 5 inches (Anderson and others, 1974).

Sampling Program

East and Chaska Creeks were sampled 12 times, as shown in table 1. Field measurements of discharge, air and water temperatures, specific conductance, dissolved oxygen, and pH were obtained with each sample. A sample for 5-day biochemical oxygen demand (BOD) was generally obtained with the standard samples that were analyzed for dissolved and suspended organic carbon, chloride, total and dissolved phosphorus, dissolved and suspended solids, dissolved sulfate, turbidity, dissolved ammonia, dissolved organic nitrogen, dissolved nitrite plus nitrate nitrogen, and total ammonia plus organic nitrogen.

Table 1.—Sampling schedule for East and Chaska Creeks and Courthouse Lake

C, chlorophyll *a*; B, BOD; S, standard sample; SB, standard sample near lake bottom; SS standard sample near lake surface; M, metals plus oil and grease; P, pesticides; PP, phytoplankton;

Sampling Date	East Creek	Chaska Creek	Courthouse Lake
8-30-79	S,B	S,B	SS,SB,C,PP
9-27-79	S,B	S,B	—
10-30-79	S,B	S,B	—
1-14-80	S	S	—
3-25-80	S,M	S,M	SS,PP
4-30-80	S,B	S,B	SS,C,PP
5-30-80	S,B	S,B	—
6-12-80	S,P	S,P	—
6-24-80	S,B	S,B	SS,PP
7-17-80	S,M	S,M	—
7-23-80	B	B	—
8-22-80	S,B	S,B	SS,SB,C,PP

Courthouse Lake was sampled five times. The constituents determined were the same as for the creeks except that turbidity and suspended solids were not determined and dissolved sulfate was determined only twice. Only total concentrations for the nitrogen-species part of the analysis were determined in the first sample. Pesticides, metals, and oil and grease were not determined for Courthouse Lake samples.

Each sample was analyzed for phytoplankton concentrations and taxonomic identification of the dominant phytoplankton genera. Measurement of Secchi-disk transparency and samples for chlorophyll a concentration were obtained each time, except in March 1980 when the lake was ice covered and primary productivity should have been near the annual minimum.

The August 1979 and August 1980 samplings of Courthouse Lake included samples taken near the bottom to determine whether constituent concentrations varied with depth. The constituents sampled were the same as those sampled at the surface, except that chlorophyll and phytoplankton were not analyzed and suspended and dissolved organic carbon concentrations were determined only on the final bottom sample. The August 1980 samples of Courthouse Lake were analyzed for concentrations of major cations and anions, dissolved silica, dissolved fluoride, and total alkalinity in addition to the other constituents.

Methods

Streamflow measurements were obtained by standard U.S. Geological Survey methods (Carter and Davidian, 1968). Field specific conductance, pH, dissolved oxygen, and water temperatures were determined in situ using meters according to methods of the American Public Health Association and others (1976) and Brown and others (1970). Meters were calibrated before and after each sampling. Stream samples were depth-integrated at multiple points in the cross section and composited. Lake samples collected near the water surface were obtained near the center of the lake with a point sampler near the depth having the maximum dissolved-oxygen concentration and were generally composited from multiple depths above this zone. Samples were obtained near the lake bottom from a point sampler within 7 feet of the bottom at the deepest part of the lake. Vertical profiles were obtained near the center of the lake above the point of maximum depth.

Samples were filtered and (or) preserved at the site before shipment to the U.S. Geological Survey central laboratory in Doraville, Ga. for analysis. Five-day BOD's were determined by the azide modification of the iodometric titration method (American Public Health Association and others, 1976). The procedures used for preservation and analysis of water samples are specified for biological constituents by Greeson and others (1977), inorganic constituents by Skougstad and others (1979), and organic constituents by Goerlitz and Brown (1972).

WATER QUALITY OF EAST CREEK

Physical Characteristics and Major Inorganic Constituents

The flow of East Creek was measured a total of 12 times, coincidental with the sampling. The measured discharge of East Creek ranged from 0.22 ft^3/s on July 17, 1980, to 6.6 ft^3/s on August 30, 1979.

Figure 2 shows that East Creek discharges were generally low in winter, but were lowest near the end of summer 1980. Peak discharges were notable in March 1980 from snowmelt and in August 1979 and June 1980 from rainfall. Water temperatures followed normal seasonal variations. The lowest temperature of 1.0°C was measured on January 14, 1980, and the highest, 29.5°C, was measured on July 17, 1980.

Dissolved oxygen (DO) concentrations also varied seasonally. The dependence of dissolved-oxygen concentration on water temperature is indicated by their correlation coefficient of -0.91, based on 10 coincidental measurements. Gases, such as oxygen, become less soluble as the water temperature increases. Riffle areas upstream from the East Creek site apparently aerate the water and keep the dissolved oxygen nearly saturated. The DO ranged from only 94 to 105 percent of the saturation concentration, except on April 30, 1980, when it reached 126 percent. This supersaturation could have resulted from photosynthesis in the stream or increased water temperatures that reduced the oxygen solubility downstream from the aeration point.

Measurements of pH showed that East Creek is somewhat alkaline. The pH varied no more than 0.4 units around the mean of 7.9 and showed no discernible seasonal trends.

Turbidity of the creek water had a mean of 4.3 nephelometric turbidity units (NTU). Although only 2.5 NTU was measured in the March snowmelt-runoff sample, turbidity was highest, 17 NTU, in the June rainfall-runoff sample. Soils exposed to erosion probably contributed substantial quantities of sediment, increasing the turbidity of this sample.

Turbidity had a fair correlation with 11 coincidental measurements of suspended-solids concentration, resulting in a coefficient of 0.63. Suspended-solids concentration was also highest, 25 mg/L, in the June runoff sample, but was at the mean of 15 mg/L in the March runoff sample. Suspended-solids concentration also was high, 23 mg/L, in the January 14, 1980, sample and will be discussed later.

The 11 measurements of dissolved-solids concentration in East Creek correlated strongly with 11 measurements of specific conductance, resulting in a coefficient of 0.96. Both had coincidental variations during the sampling. The dissolved-solids concentration and specific conductance were lowest in samples obtained during the highest discharge (August 1979 and March and June 1980), because of dilution. Higher concentrations of dissolved solids at lower discharges imply that East Creek is supplied by a base flow of ground water high in dissolved constituents. Both the dissolved-solids concentration and specific conductance were highest in the sample collected January 14, 1980, 664 mg/L and 1,022 umhos per centimeter at 25°C, respectively.

Dissolved-sulfate concentrations in East Creek ranged from 30 to 68 mg/L, having a mean concentration of 45 mg/L. A correlation coefficient of -0.79 between 10 measurements of sulfate and streamflow suggests that the dissolved sulfate in East Creek may be from ground water. A sample of ground water obtained from outwash near Chaska had 1.2 milliequivalents per liter or 58 mg/L of dissolved sulfate. A range in dissolved-sulfate concentration from 5 to 500 mg/L and a median concentration of 120 mg/L was observed in glacial sand and gravel aquifers in the area (Anderson and others, 1974).

Concentrations of chloride in East Creek ranged from 20 to 31 mg/L, having a mean concentration of 25 mg/L, except for the sample collected January 14, 1980. Variations in chloride concentration, including the January 1980 sample, correlated well with the specific conductance and dissolved-solids concentrations in 11 coincidental samples, resulting in coefficients of 0.88 and 0.87, respectively.

The sample collected January 14, 1980, had an extremely high chloride concentration of 180 mg/L. High dissolved- and suspended-solids concentrations and high specific conductance were also observed in this sample. East Creek was probably receiving drainage from a site with a high concentration of chloride, such as a snow-dumping site or a road treated with salt.

Nitrogen, Phosphorus, Organic Carbon, and Biochemical Oxygen Demand

Figure 3 shows the concentrations of various nitrogen species determined in East Creek. Total ammonia plus organic nitrogen concentrations correlated well with streamflow in 10 coincidental measurements, resulting in a coefficient of 0.92. An average of 47 percent of the ammonia in the runoff samples collected in August 1979 and March 1980 was suspended. The total and dissolved ammonia plus organic nitrogen concentrations were highest during spring runoff, 2.4 and 1.5 mg/L, respectively, and lowest when the measured discharge was lowest. The dissolved organic nitrogen averaged 88 percent of the dissolved ammonia plus organic nitrogen. These two nitrogen forms showed strongly similar variations in concentration.

The measured concentrations of dissolved ammonia nitrogen are shown in figure 3 as the difference between the dissolved ammonia plus organic nitrogen and the dissolved organic nitrogen. Ammonia concentrations were generally low, but increased during winter and reached a peak concentration of 0.43 mg/L during spring runoff. This increase is considered a normal occurrence. Ammonia is released from decomposition of accumulated detritus and there are minimal plant populations to utilize it (Reid and Wood, 1976).

The average concentration of nitrite plus nitrate nitrogen was 0.29 mg/L, or 30 percent of the total-dissolved nitrogen, except in January and March 1980 when the nitrite plus nitrate nitrogen concentrations were much higher. The 1.6 mg/L in January comprised about 55 percent of the total dissolved nitrogen. A possible source of nitrates in East Creek could be runoff from livestock-feeding pens, but the presence of feeding pens in the watershed has not been determined.

Total phosphorus concentration in East Creek averaged 0.06 mg/L, except during spring runoff in March when the concentration was 0.73 mg/L. This high spring concentration was probably the result of runoff of phosphorus applied as fertilizer or leached from detritus accumulated in the watershed. Minor increases in concentration were also observed during runoff in August 1979 and June 1980 (fig. 4), but the magnitude was less than in spring.

Dissolved phosphorus generally comprised about 50 percent of the total phosphorus. During spring runoff, 0.26 mg/L dissolved phosphorus was found. The average concentration during the rest of the year was 0.04 mg/L.

Much of the phosphorus during runoff was suspended, indicating that runoff probably washed particulate phosphorus into the stream. A correlation coefficient of 0.71 between 11 suspended phosphorus measurements and discharge supports this relationship.

Dissolved organic carbon (DOC) concentrations were reasonably constant during the sampling, having a mean concentration of 10 mg/L. A substantial decline in DOC concentration occurred in the last two samples (fig. 5). Observations by Wetzel (1975) support the suspicion that DOC concentrations introduced during runoff in August 1979

declined toward the low levels found in ground water, but increased and were maintained through winter as organic carbon was leached from accumulated leaf litter. During spring runoff DOC was diluted by snowmelt and concentrations did not increase, but the DOC load was about 3 times the average load during the sampling program. Low runoff in July and August 1980 introduced little DOC to the creek, probably because most was derived from ground water that generally has low concentrations of organic carbon.

Generally, 10 percent of the organic carbon in East Creek was in the suspended form (SOC). The percentage increased during spring runoff to as much as 23 percent.

Eight samples of raw, untreated East Creek water were analyzed for 5-day BOD. Runoff was only measured in August 1979. The highest BOD, 4.0 mg/L, occurred in this sample, followed by a decline to 1.1 mg/L in the following sample. The BOD increased in October 1979 to 3.9 mg/L, probably because of the influx of decaying vegetation.

Determinations of BOD were made again on April 30, 1980, and had declined to 2.1 mg/L. BOD increased again on May 30 to 3.4 mg/L, although discharge decreased. The BOD declined in the final three samples to 0.9 mg/L on August 22, probably because fewer biodegradable materials were present in the creek at the lower discharges.

These BOD's were uninhibited, allowing oxidation of both carbonaceous and nitrogenous materials in the water. BOD had correlation coefficients greater than 0.80 with dissolved, suspended, and total organic carbon, dissolved organic nitrogen, and total phosphorus. A correlation coefficient of 0.72 between eight BOD measurements and streamflow indicates that much of the BOD in East Creek is derived from surface runoff.

Metals, Oil and Grease, and Pesticides

Concentrations of selected metals and oil and grease were determined from two samples collected at East Creek. A high-flow measurement was made on March 25, 1980, at a discharge of 6.3 ft^3/s, and a base-flow measurement was made on July 17, 1980, when the discharge was 0.22 ft^3/s.

The base-flow concentrations of metals are probably similar to the concentrations in the ground water. No oil and grease, cadmium, or copper were found in the base-flow sample from East Creek. The concentrations of other metals were at low levels, and most had lower concentrations than in the runoff. Chromium, however, had a concentration of 23 ug/L in the base-flow sample, compared to 1 ug/L in the runoff sample. Virtually the same concentrations of chromium occurred in samples from Chaska Creek, indicating that this concentration of chromium occurs in ground water discharging to these creeks.

Oil and grease and copper, not detected in the base-flow sample, were found at low concentrations during spring runoff. Cadmium was not detected during runoff, and concentration of mercury, less than 0.1 ug/L, was the same as during base flow.

Concentrations of oil and grease (2 mg/L) and lead (130 ug/L) in runoff exceeded recommended limits of no oil and grease and 50 ug/L lead for public water supplies (National Academy of Sciences, National Academy of Engineering, 1972). Iron and manganese concentrations exceeded recommended limits in both the base-flow and high-flow samples, but the recommendations are for the soluble phase of these constituents and the analysis determined only the total concentrations. The concentration of chromium at base-flow was about half the recommended maximum concentration, 0.05 mg/L.

The concentration of selected pesticides in East Creek was determined from the sample obtained June 12, 1980. Organochlorine and organophosphorus insecticides, PCB's, and PCN's were not detected in the sample. 2,4-D was the only chlorinated phenoxy acid herbicide detected. The 2,4-D concentration of 0.07 ug/L was far below the 48-hour LC50 (the concentration lethal to 50 percent of the test subjects in a 48-hour period) of more than 50 mg/L for spot fish, Leiostomus xanthurus (Stewart and others, 1975).

Atrazine and simazine were the only triazine herbicides detected in East Creek. Atrazine, which had a concentration of 0.40 ug/L, was the second-highest-selling herbicide by weight in Carver County in 1976 (Minnesota Department of Agriculture, written commun., 1977). The concentration of atrazine was far below 12.6 mg/L, the acute oral LC50 for fish (Stewart and others, 1975). The concentration of 0.06 ug/L simazine was also well below the 48-hour LC50 of 5.0 mg/L for fish (Stewart and others, 1975).

Alachlor, an anilide herbicide, had a concentration of 0.32 ug/L. In 1976, alachlor was the highest-selling herbicide by weight in Carver County, Minn. (Minnesota Department of Agriculture, written commun., 1977). The 48-hour LC50 of alachlor for bluegills is 2.3 mg/L (Stewart and others, 1975).

WATER QUALITY OF CHASKA CREEK

Physical Characteristics and Major Inorganic Constituents

Flow in Chaska Creek averaged twice that of East Creek. The highest measured discharge, 24.0 ft^3/s, occurred on March 25, 1980, during snowmelt runoff. The lowest discharge, 0.51 ft^3/s, was measured on July 23 when a previously missed BOD was sampled. Two rainfall runoff events were sampled on August 30, 1979, and June 12, 1980, having discharges of 11.0 and 11.7 ft^3/s, respectively.

The DO of Chaska Creek was nearly saturated throughout the sampling. It ranged from 14.1 mg/L on March 25 to 8.2 mg/L on July 17.

Chaska Creek had an alkaline mean pH of 7.9 units. The range from 7.5 to 8.2 units followed no discernible trends.

The mean turbidity of 10.7 NTU at Chaska Creek was much higher than at East Creek. The highest turbidity of 50 NTU was found during spring runoff on March 25. The 11 measurements of turbidity correlated with discharge, resulting in a correlation coefficient of 0.96, substantially higher than the coefficient of 0.31 for East Creek.

The concentration of suspended solids generally varied with the turbidity and discharge. The highest concentration, 860 mg/L, occurred in May 1980, and did not coincide with peaks in other constituents or physical measurements. This May concentration seems to be erroneous because it was well above the mean of 27.3 mg/L for the other suspended-solids samples and the next highest concentration, 76 mg/L on June 12.

Dissolved solids and specific conductance, although generally strongly associated, had a correlation coefficient of only 0.70 in 11 measurements. However, both had negative correlation coefficients of about -0.80 with streamflow, turbidity, and some forms of nitrogen, phosphorus, and organic carbon. These constituents and physical measurements are associated with runoff, indicating that the dissolved solids and specific conductance are probably associated with some other source of input to the stream, such as ground water.

Dissolved sulfate is also probably introduced to the creek from ground-water discharge. The highest concentration, 53 mg/L, occurred at the lowest sampled discharge, and the lowest concentration, 17 mg/L, occurred during spring runoff. The mean sulfate concentration, 35 mg/L, was lower than the concentration in East Creek.

Ground water seems to be the primary source of chloride in Chaska Creek. The highest concentration of 28 mg/L occurred on July 17, and the lowest of 14 mg/L occurred during spring runoff. The mean concentration was about 20 mg/L, having no anomalous concentrations. Chaska Creek chloride concentrations had correlation coefficients of 0.55 with specific conductance and 0.65 with dissolved-solids concentrations, much lower than East Creek.

Nitrogen, Phosphorus, Organic Carbon, and Biochemical Oxygen Demand

The mean concentration of all forms of nitrogen regularly sampled at Chaska Creek, except suspended ammonia plus organic nitrogen, were higher than at East Creek. The highest concentration of most forms of nitrogen occurred during spring runoff. Peak concentrations also occurred during rainfall runoff (fig. 6).

Nitrite plus nitrate nitrogen concentrations were high during the winter. The highest concentration, 2.0 mg/L, was found in the January 14 sample. The concentration of 1.1 mg/L determined on June 12 was probably the result of runoff from agricultural fertilizer applications. These forms of nitrogen in Chaska Creek are probably introduced from a source similar to that of East Creek.

Ammonia nitrogen concentrations were negligible throughout most of the year. In January, 0.17 mg/L ammonia was detected in the water. The highest concentration, 1.5 mg/L, occurred in the runoff sampled in March. The average ammonia concentration in Chaska Creek was more than twice the concentration in East Creek.

The mean concentration of dissolved organic nitrogen in Chaska Creek was 0.78 mg/L, about the same as in East Creek. Greater variations in concentration occurred at Chaska Creek with peak concentrations of 1.7 and 1.4 mg/L coinciding with the runoff in March and June, respectively. Dissolved organic nitrogen concentrations were lowest, 0.21 mg/L, when the measured discharge was lowest.

The mean total ammonia plus organic nitrogen concentration in Chaska Creek was 12 percent higher than in East Creek, but Chaska Creek had an average 29 percent less suspended ammonia plus organic nitrogen than East Creek. Comparing figure 3 with figure 6 shows that suspended ammonia plus organic nitrogen concentrations at Chaska Creek were negligible during most of the year, including the runoff sampled in August 1979 when East Creek had 1.2 mg/L of this constituent. Suspended ammonia plus organic nitrogen comprised 33 percent of the total, 4.8 mg/L, in the March sample of runoff, and 17 percent of the total in the June runoff sample. The lowest concentration of total ammonia plus organic nitrogen, 0.42 mg/L, occurred during the lowest sampled discharge in July 1980. Total ammonia plus organic nitrogen concentrations in Chaska Creek had a 0.97 correlation coefficient with 10 measurements of streamflow.

The mean total-phosphorus concentration at Chaska Creek, 0.19 mg/L, was 54 percent higher than at East Creek. In East Creek only 48 percent of the phosphorus was dissolved, but in Chaska Creek 76 percent of the phosphorus was dissolved.

Phosphorus in runoff is generally attached to sediment particles or bound in compounds of low solubility. Phosphorus in runoff in Chaska Creek was generally in the undissolved or suspended form.

The peaks in total phosphorus concentration at Chaska Creek coincide with runoff in August 1979 and in March and June 1980 (fig. 7). In the August and June samples, dissolved phosphorus represented 79 and 60 percent of the total phosphorus, respectively. In March, 96 percent of the 0.48 mg/L total phosphorus was dissolved. The high percentage of dissolved phosphorus in Chaska Creek may be the result of runoff from agricultural fertilizers, which are generally applied in a soluble form. Dissolved phosphorus is a nutrient immediately available to enhance phytoplankton growth and could support blooms in receiving waters.

Concentrations of dissolved and suspended organic carbon at Chaska Creek averaged about the same as at East Creek, although the range in concentration was greater. The highest DOC concentration, 15 mg/L, occurred during runoff in both March and June. The July sample had the lowest DOC concentration of 3.8 mg/L. Peak DOC concentrations also occurred in October, apparently from decomposition of leaf litter, and during runoff in August 1979.

The SOC at Chaska Creek represented an average 9 percent of the total organic carbon. Peak concentrations occurred during runoff. The highest concentration, 4.2 mg/L in March, comprised 19 percent of the total organic carbon. The lowest SOC concentration, 0.4 mg/L, occurred in samples collected in October 1979 and in July and August 1980.

Eight samples of Chaska Creek water were analyzed for uninhibited 5-day BOD. Only one runoff event was sampled in August 1979 and had a BOD of 2.2 mg/L. The highest BOD of 3.8 mg/L occurred in the May sample when discharge was only 1.7 ft^3/s. A higher concentration of biogradeable substances apparently were in the creek at this time than at other times. The lowest BOD, 0.8 mg/L, was determined on July 23, 1980, a few days after the chemical sampling. Although not statistically significant, the mean BOD of 1.84 mg/L at Chaska Creek was less than the 2.41 mg/L of East Creek.

The BOD in Chaska Creek had correlation coefficients greater than 0.75 with five dissolved ammonia and seven suspended phosphorus measurements. The high correlation coefficient of 0.89 between seven BOD and suspended solids measurements is considered inconclusive because the relationship is affected by the erroneously high suspended-solids concentration in the May sample.

Metals, Oil and Grease, and Pesticides

Two samples of Chaska Creek water were analyzed for concentrations of selected metals and oil and grease. High-flow was measured on March 25, when the discharge was 24 ft^3/s. Base flow was measured on July 17, when the discharge in the creek was 0.99 ft^3/s.

Base-flow concentrations of metals and oil and grease in Chaska Creek were virtually identical to those of East Creek. Notable differences were the lack of lead, the detection of only 1 ug/L copper, and higher concentrations of iron and manganese, 670 and 340 ug/L, respectively.

The high-flow sample had increased concentrations of most of the metals analyzed. Low concentrations of lead and oil and grease were found, 4 ug/L and 2 mg/L, in addition to increased concentrations of arsenic, copper, iron, manganese, and zinc.

Cadmium was not found in the high-flow measurement, and mercury remained at the concentration of less than 0.1 ug/L. The concentration of chromium in Chaska Creek was highest in the base-flow measurement, 22 ug/L, and only 1 ug/L was found in the high-flow measurement. Relatively higher concentrations of chromium are probably present in the ground water supplying base flow to these creeks.

Chaska Creek generally meets water-quality criteria for public water supplies, except the concentration of 2 mg/L oil and grease. The National Academy of Sciences, National Academy of Engineering (1972) recommends that none should be present.

Analyses for selected pesticides, PCB's, and PCN's were made on the sample collected from Chaska Creek on June 12, 1980, when the discharge was about 12 ft^3/s. The same pesticides present in East Creek were found in the sample from Chaska Creek. Concentrations of alachlor, atrazine, and 2,4-D were higher in Chaska Creek, but still far below the 48-hour LC50 for these pesticides (Stewart and others, 1975).

WATER QUALITY OF COURTHOUSE LAKE

Vertical Profiles

Measurements of dissolved oxygen (DO), water temperature, pH, and specific conductance were obtained at specific depths in Courthouse Lake with each of the 5 samplings. The DO, pH, water temperature, and Secchi-disk transparency are shown in figure 8. The results of specific conductance measurements are not shown.

The vertical profile obtained in August 1979 had an epilimnion extending to about the measured Secchi-disk transparency of 16.5 feet. The water temperature, about 22°C, and pH were fairly constant throughout this depth, indicating that the epilimnion is subject to mixing by wind action.

The thermocline (metalimnion) occurred from about 18 to 30 feet in depth. The temperature in this region declined from 21.0° to 7.0°C. Below about 30 feet the temperature in the hypolimnion decreased slowly with depth to 5.0°C at 48 feet.

The concentration of DO in August 1979 was nearly saturated near the surface but was supersaturated between 10 and 21 feet. The protuberance in the DO curve between 10 and 21 feet delineates the region where light intensity is sufficient for phytoplanktonic photosynthesis and nutrient availability is high. DO concentrations declined rapidly below 21 feet to nearly 0 below 36 feet as decompositional processes utilized the available oxygen.

The pH of Courthouse Lake in August 1979 declined rapidly in the thermocline where the production of carbon dioxide from respiration exceeded consumption by photosynthesis. The pH ranged from 8.4 at the surface to 7.5 near the bottom, whereas the pH of more productive lakes in the area at this time of year may range from 10.0 near the surface to 6.5 near the bottom (Tornes and Have, 1980).

The vertical profile of March 1980 was obtained under a decaying ice cover. The water temperature was a constant 4.0°C throughout. The water would ordinarily be 0.0°C near the surface, but solar heating had apparently warmed this water, eliminating the winter inverse stratification. DO concentration was high in the upper 36 feet of the lake. Below 36 feet the DO concentration declined rapidly to a depth of 42 feet, then declined more slowly. DO concentration near the sediments, about 2.5 mg/L, generally reduces the release of phosphates in the sediments to the water, which might occur if the bottom waters were anoxic.

The pH of Courthouse Lake was virtually constant throughout the vertical profile of March 1980. A slight decline in pH occurred below 36 feet in depth where decomposition had apparently increased the concentration of carbon dioxide.

The April 30, 1980, profile showed the beginnings of summer stratification. The upper boundary of the thermocline occurred at a depth of about 9 feet, but there was no distinct lower boundary. Water temperatures decreased with depth from 15.5°C at 1 foot to 4.5 °C at 51 feet.

DO in the April profile was saturated near the surface, but became supersaturated to a depth of about 20 feet. DO concentrations declined rapidly below 20 feet. The maximum measured DO in this profile was 12.7 mg/L at 18 feet in depth. The pH followed a similar pattern, having the highest values between 12 and 18 feet in depth. This layer of water was the region where phytoplankton productivity was highest. The density of phytoplankton in this layer may have reduced the transparency, extinguishing the measured Secchi-disk transparency at this depth.

Two months later, the profile on June 24 still had an indistinct thermocline between 12 and 25 feet in depth. DO was supersaturated to a depth of about 25 feet. The highest DO concentration measured was 13.3 mg/L, which occurred at about the same depth as in the April profile. The pH was highest between 10 and 22 feet, with values ranging between 8.1 and 8.2. Water temperatures near the surface were about 25°C. Secchi-disk transparency was not measured with this profile.

The June profile of Courthouse Lake was extended to a depth of only 44 feet, but at this depth some differences from the April profile can be noted. The water temperature increased 1.5°C indicating that the water at this depth may have mixed with the warmer upper layers by diffusion or conduction. DO and pH declined in the hypolimnion between April and June. This is the result of decompositional processes that utilize sedimenting organic matter and DO and produce carbon dioxide that lowers pH.

The profile on August 22 had a well-mixed epilimnion in the upper 16 feet of the lake. The highest productivity in the lake appeared to be in the thermocline, which extended to a depth of about 27 feet. The magnitude of DO and pH bulges in the profile was reduced compared to profiles obtained earlier in the year. At the time of day these measurements were made, photosynthesis may not have produced the quantity of DO observed in previous measurements made later in the day.

The Secchi-disk transparency of Courthouse Lake in August 1980 was reduced compared to previous samplings. The reduction in transparency probably resulted from the high concentration of phytoplankton in the sample.

The hypolimnetic DO in the profile in August 1980 was much higher than in August 1979. Higher DO was probably the result of more complete oxygenation of the hypolimnion during turnover than in the previous year. Increased DO in the hypolimnion can inhibit the release of soluble phosphates from the lake sediments (Wetzel, 1975), making less of this nutrient available to enhance phytoplankton growth.

Measurements of specific conductance, which correlate closely with dissolved-solids concentrations, had only minor variations between profiles. The specific conductance of about 370 umhos in the epiliminion increased through the thermocline to between 400 and 435 umhos in the hypolimnion. The higher specific conductance in the hypolimnion was probably the result of the release of solutes from the decomposition of detritus.

The only profile of specific conductance that diverged from the usual pattern was obtained in March. The conductance was a virtually constant 400 umhos during most of the profile, increasing about 10 umhos below about 40 feet in depth. Slightly lower conductance near the surface indicates that water from snowmelt or ice melt had mixed with surficial waters.

The DO profiles shown in figure 8 are termed clinograde and are generally considered typical of eutrophic lakes (Wetzel, 1975). Courthouse Lake may, therefore, be considered eutrophic based on the DO profiles only.

Inorganic Constituents

Each sample of Courthouse Lake was analyzed for dissolved-solids concentrations and, except for the hypolimnetic sample in August 1979, dissolved chloride. The average dissolved-solids concentration in the epilimnion of Courthouse Lake was 238 mg/L. The 11-percent precision of the analysis for dissolved solids (Skougstad and others, 1979) adequately accounts for the random flucutations in concentration. The hypolimnetic dissolved-solids concentration was 11 to 16 percent higher than in the epilimnion, based on the samplings in August 1979 and 1980. This probably resulted from dissolution of substances released by decomposition in the hypolimnion.

Dissolved-chloride concentrations ranged from 10 to 12 mg/L having a mean of 10.6 mg/L. The precision of the analysis could allow this range of values around the mean, indicating that chloride concentrations had no discernible fluctuations. Increased chloride concentrations are generally the result of pollution (Wetzel, 1975), so periodic sampling for this constituent might provide evidence of pollution of the lake.

The sample collected at Courthouse Lake in August 1980 was analyzed for concentrations of major cations and anions and silica in both the hypolimnion and epilimnion. These analyses reveal that the ionic constituents of the lake water are predominantly bicarbonates of calcium and magnesium.

Calcium comprised 48 percent of the milliequivalents per liter of the major cations in the epilimnion. The remainder was 42 percent magnesium, 6 percent sodium, and 4 percent potassium. Alkalinity as calcium carbonate was 64 percent of the milliequivalents per liter of the major anions. Sulfate was 28 percent, chloride was 8 percent, and fluoride was less than 1 percent of the anions.

Calcium, magnesium, sodium, and potassium comprised 51, 36, 10, and 3 percent of the cations in the hypolimnion, respectively; and alkalinity (as calcium carbonate), sulfate, chloride, and fluoride accounted for 70, 22, 7, and less than 1 percent of the anions, respectively. Magnesium, potassium, chloride, fluoride, and sulfate each had virtually the same concentration in the hypolimnion and epilimnion.

The concentration of 10 mg/L sodium in the hypolimnion was almost twice the 5.4 mg/L measured in the epilimnion. An explanation for this difference was not found and, according to Wetzel (1975), the distribution of sodium is uniform and has very little seasonal variation. This difference may be related to the hydrology of the lake, because ground water containing a relatively high concentration of sodium may be flowing into the hypolimnion.

The calcium concentration and alkalinity were substantially higher in the hypolimnion than in the epilimnion of the lake. During periods of high productivity, phytoplankton and macrophytes utilize carbon dioxide in the euphotic zone faster than it can be replaced by atmospheric or hypolimnetic carbon dioxide. This will raise the pH of surficial waters and can cause precipitation of calcium carbonate (Kelts and Hsu, 1978). Calculations described by Kelts and Hsu (1978) were used to compute the ratio of the ionic activity product of calcium carbonate to its equilibrium constant at the measured temperatures. The ratio was greater than 1.00 (4.28) in the epilimnion, indicating supersaturation of calcium carbonate, and less than 1.00 (0.16) in the hypolimnion, indicating undersaturation. Calcium concentrations and alkalinity would be reduced in the epilimnion by precipitation of calcium carbonate, much of which probably redissolves in the hypolimnion with reduced pH and the availability of free carbon dioxide.

The silica concentration of 3.0 mg/L in the hypolimnion was substantially higher than the epilimnetic concentration of 0.8 mg/L. This distribution of silica occurs commonly in lakes, primarily because of assimilation of silica by diatoms in the epilimnion, and subsequent sedimentation of the diatoms (Wetzel, 1975).

Phosphorus, Nitrogen, and Organic Carbon

Total and dissolved-phosphorus concentrations were determined for each of the five samples of the Courthouse Lake epilimnion. The concentration of total and dissolved phosphorus in the hypolimnion was determined only for the August 1979 and August 1980 samplings.

Epilimnetic phosphorus depletion is indicated by the concentration of 0.01 mg/L total phosphorus in August 1979. Most of this phosphorus is probably contained in the cells of phytoplankton and should be suspended. The results of the analysis indicate that most of the phosphorus was in the dissolved state. The analysis is not considered accurate at this concentration (Skougstad and others, 1979), so the actual dissolved-phosphorus concentration was probably considerably less than the 0.01 mg/L found in the sample.

The hypolimnetic waters of Courthouse Lake contained substantial quantities of phosphorus in August 1979. The total phosphorus concentration of 0.47 mg/L, sampled 5 feet from the lake bottom, was mostly dissolved phosphorus, 0.43 mg/L. Because the hypolimnetic waters were virtually anoxic, most of this phosphorus was probably released from the lake sediments.

The surficial waters of Courthouse Lake contained 0.05 mg/L total and 0.03 mg/L dissolved phosphorus in March 1980. This probably represents the phosphorus remaining in the upper lake waters following the fall turnover and subsequent phosphorus depletion through the winter by light and temperature-limited phytoplankton activity.

The total and dissolved phosphorus concentrations, 0.03 and 0.01 mg/L, respectively, found near the surface in April 1980 were less than in the previous sampling. This phosphorus depletion probably resulted from uptake and sedimentation by phytoplankton. A substantial spring turnover could have introduced additional phosphorus to the surface waters of the lake, but because the bottom waters were well oxygenated through the winter (see vertical profiles section), sufficient phosphorus may not have been released from the sediments to raise the surface concentration after turnover.

As the summer progressed, total and dissolved phosphorus became depleted in the epilimnion. By August 1980, analyses for low-level, total-, and dissolved-phosphorus concentrations (applicable range 0.001 to 0.020 mg/L) showed that the epilimnion had only 0.003 mg/L total and 0.000 mg/L dissolved phosphorus.

The hypolimnion of the lake in August 1980 had 0.15 mg/L total and dissolved phosphorus. The greater concentration of dissolved oxygen near the bottom, 3.1 mg/L, was probably preventing the release of soluble phosphate in the quantities seen in the August 1979 sample from the hypolimnion.

The August 1979 sample from Courthouse Lake was analyzed for total concentrations of the major nitrogen species. The 0.40 mg/L nitrogen found in the epilimnion was composed of 0.39 mg total organic and 0.01 mg total ammonia nitrogen. No nitrite or nitrate nitrogen was found. About 75 percent of the organic nitrogen was in the dissolved state because 0.30 mg/L dissolved ammonia and organic nitrogen was found in this sample. Phytoplankton had apparently used up almost all the available forms of nitrogen, leaving only organic forms in the water.

The hypolimnetic sample obtained in August 1979 had [illegible] mg/L nitrogen, all of which was dissolved ammonia plus organic nitrogen. Over [illegible] percent of this, [illegible] mg/L, was dissolved ammonia, probably released from decomposition at or near the lake bottom. The total organic nitrogen was higher in the hypolimnion than in the epilimnion, and was also probably derived from decomposition of organic material near the bottom.

The measurement made in March 1980 showed that the concentration of total ammonia plus organic nitrogen had declined to 0.23 mg/L through the winter. Dissolved ammonia plus organic nitrogen had a concentration of 0.22 mg/L, leaving only 0.01 mg/L in the seston of Courthouse Lake. The dissolved ammonia concentration of 0.07 mg/L, which probably mixed into surficial waters during fall turnover, leaves only 0.15 mg/L dissolved organic nitrogen of the dissolved ammonia plus organic nitrogen. The reduction in dissolved organic nitrogen after the August 1979 sample was probably the result of bacterial degradation of the organic nitrogen and subsequent conversion to other forms of nitrogen. Some of this may have been lost from the lake as molecular nitrogen but much was probably converted to nitrite plus nitrate nitrogen, which was not found in the previous sample but had a concentation of 0.05 mg/L in March 1980.

Dissolved ammonia was not found in the sample of Courthouse Lake collected in April 1980. Apparently the ammonia had been converted to other forms of nitrogen or utilized by phytoplankton. Nitrite plus nitrate nitrogen concentrations declined to 0.03

mg/L. This decrease continued throughout the summer, as expected, because low quantities of nitrite nitrogen can readily be converted to nitrate nitrogen, which is the form of nitrogen best utilized by green plants (Wetzel, 1975).

Total dissolved nitrogen, dissolved and suspended ammonia plus organic nitrogen, and dissolved organic nitrogen all had substantially higher concentrations in April than in the previous sampling. Release of nitrogen from the sediments was not significantly affected by the amount of oxygen present in the water. Nitrogen released to the bottom waters of the lake could have, therefore, increased the surficial nitrogen concentrations during spring turnover, although phosphorus concentrations declined.

In April, 0.17 mg of the 0.60 mg/L ammonia plus organic nitrogen was suspended. The remaining ammonia plus organic nitrogen, 0.43 mg/L, was dissolved organic nitrogen. It can be assumed that the suspended ammonia plus organic nitrogen was all suspended organic nitrogen because ammonia concentrations in the oxygenated epilimnion tend to be very low (Wetzel, 1975). Approximately 28 percent of the organic nitrogen was, therefore, suspended, and most was probably contained in the cells of phytoplankton.

The sample collected in June 1980 showed expected seasonal declines in the concentration of total ammonia plus organic nitrogen and dissolved nitrite plus nitrate nitrogen to 0.44 and 0.01 mg/L, respectively. The presence of 0.03 mg/L ammonia nitrogen in the sample is not easily explained, but could have been derived from sources external to the lake, such as runoff from the surrounding watershed.

The concentration of dissolved ammonia plus organic nitrogen decreased from 0.43 mg/L in April to 0.08 mg/L in June. The dissolved organic nitrogen and suspended ammonia plus organic nitrogen look anomalous because they are computed from this anomalous value. Assuming that the suspended ammonia plus organic nitrogen was all organic nitrogen, it would compose about 88 percent of the total organic nitrogen. This composition does not compare favorably with other samples where the suspended organic nitrogen was less than 30 percent of the total organic nitrogen. According to Wetzel (1975), the dissolved organic nitrogen of lakes and streams is 5 to 10 times greater than particulate (suspended) organic nitrogen. In this lake, the dissolved organic nitrogen was from 2.5 to 15 times greater than the suspended ammonia plus organic nitrogen, but in the June sample it was about 14 percent of the concentration of suspended ammonia plus organic nitrogen. The reported concentration of dissolved ammonia plus organic nitrogen was, therefore, probably erroneously low.

The August 1980 determination showed further seasonal decline in concentrations of total ammonia plus organic nitrogen, 0.35 mg/L, and dissolved nitrite plus nitrate nitrogen, 0.00 mg/L. The concentration of dissolved organic nitrogen also showed a seasonal decline from April. Dissolved ammonia nitrogen was not found in this sample. The suspended ammonia plus organic nitrogen composed only about 9 percent of the estimated total organic nitrogen in this sample.

Nitrogen concentrations near the bottom in August 1980 were not notably higher than epilimnetic concentrations. No dissolved nitrite plus nitrate nitrogen was found in the sample; 0.46 mg/L of the 0.54 mg/L total ammonia plus organic nitrogen was dissolved. The 0.11 mg/L dissolved ammonia leaves 0.35 mg/L dissolved organic nitrogen, only 0.03 mg/L higher than the epilimnetic concentration.

Samples of organic carbon in Courthouse Lake had minor variations in concentration, but no seasonal trends or relationships were discerned. The dissolved organic carbon in the epilimnion ranged from a high of 7.1 mg/L in August 1979 to a low of 4.8 mg/L in August 1980. Suspended organic carbon ranged from a low of 0.2 mg/L in August 1979 to a high of 0.7 mg/L in August 1980.

The ratios of dissolved to suspended organic carbon ranged from about 36:1 in August 1979 to about 7:1 in August 1980 with a mean ratio of 15:1. According to Wetzel (1975), this ratio is a rather constant 10:1 with only minor variations with respect to space and time in lakes with low to moderate productivity. Ratios show greater seasonal fluctuations, decreasing to 1:1 or less, in more eutrophic lakes. The observed fluctuations in the ratios of dissolved and suspended organic carbon may be the result of influences from outside the lake system. Organic carbon introduced to the lake from allochthonous sources could be a factor contributing to the hypolimnetic oxygen consumption observed in the vertical profiles of Courthouse Lake.

Dissolved organic carbon sampled from the hypolimnion in August 1980, 9.6 mg/L, was twice the concentration in the epilimnion. Suspended organic carbon in the hypolimnion, 0.4 mg/L, was about half the concentration in the epilimnion. The significant change in concentration with depth also deviates from the norm expressed by Wetzel (1975).

Phytoplankton

Each sampling of Courthouse Lake included quantification of the phytoplankton genera that composed more than 0.5 percent of the total number of cells per milliliter. These samples were generally composited from discrete multiple-depth samples of the epilimnion and should be representative of the epilimnetic waters, but the gregarious nature of phytoplankton in lake waters may cause the samples to be less than representative.

The total number of phytoplankton cells per milliliter was quite variable, not showing discernible seasonal trends. Lee (1970) proposed that a phytoplankton concentration of 500 to 1,000 cells/mL indicates an algal bloom. All the phytoplankton samples except the one collected in April 1980 had concentrations that exceeded the proposed criteria.

The sample collected in April 1980 had no phytoplankton cells present. This result was confirmed by the laboratory analyzing the sample and is supported by the lack of chlorophyll a. Phytoplankton were probably present in the lake, but sampling failed to retrieve a sufficient number of the organisms.

The major taxonomic groups of phytoplankton in Courthouse Lake appear to exhibit characteristic seasonal trends. Green algae division chlorophyta were well represented in all samples, except in April 1980, composing from 23 percent of the total phytoplankton cells in March to 61 percent in June. Certain types of green algae recurred seasonally and in subsequent samplings (table 2), but there was much variability in the genera that represented this division.

The division chrysophyta, represented primarily by the diatom Cyclotella, was dominant only in the March sample, accounting for 47 percent of the phytoplankton cells. A [illegible] of cold-water adapted diatoms such as Cyclotella in early spring under ice cover in temperate lakes is a common occurrence (Wetzel, 1975).

TABLE 2.--IDENTIFICATION OF COURTHOUSE LAKE PHYTOPLANKTON SAMPLES

444720093312401 - COURTHOUSE LAKE AT CHASKA, MN

PHYTOPLANKTON ANALYSES, AUGUST 1979 TO AUGUST 1980

DATE	AUG 30,79	MAR 25,80	APR 30,80	JUN 24,80	AUG 22,80
TIME	1200	1100	1022	1020	0930
TOTAL CELLS/ML	2000	7100	0	1400	5200
DIVERSITY: DIVISION	1.0	1.5	0.0	1.4	1.2
.CLASS	1.0	1.5	0.0	1.4	1.2
..ORDER	1.1	1.5	0.0	1.4	1.6
...FAMILY	1.9	1.5	0.0	1.6	2.0
....GENUS	2.0	1.5	0.0	1.6	2.6

ORGANISM	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT
CHLOROPHYTA (GREEN ALGAE)										
.CHLOROPHYCEAE										
..CHLOROCOCCALES										
...CHARACIACEAE										
....SCHROEDERIA	—	-	1600#	23	—	-	43	3	*	0
...COELASTRACEAE										
....COELASTRUM	81	4	—	-	—	-	—	-	—	-
...HYDRODICTYACEAE										
....PEDIASTRUM	81	4	—	-	—	-	—	-	—	-
...OOCYSTACEAE										
....ANKISTRODESMUS	—	-	—	-	—	-	—	-	41	1
....CHLORELLA	250	13	—	-	—	-	—	-	—	-
....OOCYSTIS	—	-	—	-	—	-	800#	57	320	6
...SCENEDESMACEAE										
....CRUCIGENIA	81	4	—	-	—	-	—	-	550	11
....SCENEDESMUS	81	4	—	-	—	-	—	-	1100#	21
..TETRASPORALES										
...COCCOMYXACEAE										
....ELAKATOTHRIX	—	-	—	-	—	-	—	-	160	3
..VOLVOCALES										
...CHLAMYDOMONADACEAE										
....CHLAMYDOMONAS	—	-	—	-	—	-	14	1	—	-
CHRYSOPHYTA										
.BACILLARIOPHYCEAE										
..CENTRALES										
...COSCINODISCACEAE										
....CYCLOTELLA	15	1	3300#	47	—	-	—	-	41	1
..PENNALES										
...NITZSCHIACEAE										
....NITZSCHIA	*	0	—	-	—	-	—	-	—	-
.CHRYSOPHYCEAE										
..CHRYSOMONADALES										
...OCHROMONADACEAE										
....OCHROMONAS	—	-	—	-	—	-	—	-	96	2
CRYPTOPHYTA (CRYPTOMONADS)										
.CRYPTOPHYCEAE										
..CRYPTOMONADALES										
...CRYPTOCHRYSIDACEAE										
....CHROOMONAS	—	-	2100#	30	—	-	250#	18	—	-
...CRYPTOMONADACEAE										
....CRYPTOMONAS	—	-	—	-	—	-	—	-	*	0
CYANOPHYTA (BLUE-GREEN ALGAE)										
.CYANOPHYCEAE										
..CHROOCOCCALES										
...CHROOCOCCACEAE										
....ANACYSTIS	—	-	—	-	—	-	290#	20	2200#	43
....[illegible]	—	-	—	-	—	-	—	-	300	6
..HORMOGONALES										
...NOSTOCACEAE										
....ANABAENA	130	7	—	-	—	-	—	-	—	-
...OSCILLATORIACEAE										
....OSCILLATORIA	1200#	62	—	-	—	-	—	-	150	3
....PHORMIDIUM	—	-	—	-	—	-	—	-	110	2
...RIVULARIACEAE										
....RAPHIDIOPSIS	—	-	—	-	—	-	—	-	82	2
PYRRHOPHYTA (FIRE ALGAE)										
.DINOPHYCEAE										
..PERIDINIALES										
...CERATIACEAE										
....CERATIUM	25	1	—	-	—	-	—	-	—	-

NOTE: # - DOMINANT ORGANISM; EQUAL TO OR GREATER THAN 15%
* - OBSERVED ORGANISM, MAY NOT HAVE BEEN COUNTED; LESS THAN 1/2%

The cryptomonads, division cryptophyta, occurred in the greatest numbers and were predominant in the March sample. The genus Chroomonas was the primary representative of this division. Wetzel (1975) states that this division also often develops dense populations during the cold periods of the year when light intensity is relatively low.

The blue-green algae, division cyanophyta, were dominant in both the August 1979 and August 1980 samples, representing 69 and 56 percent of the total cells per milliliter, respectively. Blue-green algae, many species of which are capable of fixing molecular nitrogen, will often become dominant as nitrate and ammonia nitrogen concentrations become depleted during summer (Wetzel, 1975). Oscillatoria comprised about 90 percent of the blue-green algae in August 1979, but was barely present in August 1980, accounting for only about 5 percent of this division. The population of Anacystis increased almost an order of magnitude from 290 cells/mL in June 1980 to 2,200 cells/mL in August 1980 to become the dominant genera of phytoplankton. The changing generic dominance within each division are probably indicative of changes in the lacustrine environment.

The phytoplankton identified in Courthouse Lake are generally considered tolerant of organic pollution based on a compilation of reports from 165 authors (Palmer, 1968). Scenedesmus, Oscillatoria, Chlamydomonas, and Ankistrodesmus, all identified in the samples, are in the top 10 of Palmer's (1968) rating of the 60 most pollution-tolerant algae. Pollution-tolerant genera constituted 92 percent of the phytoplankton population in August 1979, 87 percent in August 1980, and 79 percent in June 1980. The diatom Cyclotella, dominant in March, is also high on the pollution-tolerant list.

Palmer (1968) also presented an algal-pollution index for use in rating water samples for high or low organic pollution. Using the methodology presented, a score was obtained for each sample. A score of 20 or more can be taken as evidence of high organic pollution, while a score of 15 to 19 can be taken as probable evidence of high organic pollution. Lower figures indicate that the pollution is not high, that the sample is not representative, or that something is interferring with algal persistence.

Phytoplankton in Courthouse Lake do not indicate high organic pollution. Samples collected in August 1979 and August 1980 had the highest pollution-index scores of 12 and 11, respectively. Samples collected in March and June 1980 both had a score of 1.

Table 2 and figure 9 show the diversity indices for each taxonomic level of the phytoplankton samples from Courthouse Lake. These indices were computed by use of the method proposed by Wilhm and Dorris (1968). The sample collected in April was not considered to be representative and was not included in figure 9.

High diversity generally indicates a healthy environment where conditions are suitable for many phytoplankton types. Low diversity generally indicates conditions where only more specialized phytoplankton types are able to survive and dominate the population. On a seasonal basis, particularly in eutrophic temperate waters, diversity tends to increase in summer and decrease in winter (Wetzel, 1975).

The diversity indices were the same for each taxonomic level in March 1980. Table 2 shows that this is the result of having only one genus representing each division. The greatest divergences in the diversity indices of phytoplankton taxa were in August 1979 and August 1980 when many genera were identified from many divisions.

The diversity index of phytoplankton divisions and classes were coincidental and tended to be low in summer and high in spring and possibly winter. Both August samples had low division diversity because they were composed predominantly of blue-green algae, whereas the March and June samples had better representation from each division.

The diversity indices at the generic level followed the seasonal pattern described by Wetzel (1975), and were opposite that found at the division level. Although blue-green algae dominated the August 1979 and August 1980 samples, many genera within this and the other divisions identified were able to survive. The diversity indices for the other taxonomic levels fell between those for division and genus.

Trophic Status

The trophic status of Courthouse Lake was determined using Carlson's (1977) Trophic State Index (TSI) based on three trophic variables, surface chlorophyll a concentration, surface total phosphorus concentration, and Secchi-disk transparency. The TSI for each of these variables is shown in figure 10. The formulas used to calculate the TSI are:

$$TSI_{(SD)} = 10\left(6 - \frac{\ln SD}{\ln 2}\right)$$

$$TSI_{(chla)} = 10\left(6 - \frac{2.04 - 0.68 \ln chla}{\ln 2}\right)$$

$$TSI_{(TP)} = 10\left(6 - \frac{\ln \frac{65}{TP}}{\ln 2}\right)$$

where:

SD = Secchi-disk transparency, in meters,
chla = chlorophyll a concentration, in micrograms per liter, and
TP = total phosphorus concentration, in micrograms per liter.

The chlorophyll a TSI's shown were both about 36. No chlorophyll a was found in April 1980, so the TSI was zero. Carlson (1977) recommends using the summer values of the trophic variables, therefore, this April value may be ignored. According to Reckhow (1979), a lake having a TSI less than about 40 can be considered oligotrophic, a TSI greater than about 50 can be considered eutrophic, and a TSI between about 40 and 50 can be considered mesotrophic. Based on the chlorophyll a concentration, therefore, Courthouse Lake can be considered oligotrophic.

Measurements of Secchi-disk transparency in August 1979 and in April and August 1980 provided TSI's of 36, 36, and 40, respectively. Although the April TSI may be ignored, all the Secchi-disk TSI's also indicate that Courthouse Lake is oligotrophic.

Surface samples were collected for analysis of total phosphorus during each of the 5 visits to Courthouse Lake. The last sample (August 1980) was analyzed for low-level concentrations (greater than or equal to 0.001 mg/L) of phosphorus. The other samples were analyzed for phosphorus only to an accuracy of 0.01 mg/L. This may affect the significance of the results obtained in August 1979 and June 1980, because both had concentrations of total phosphorus at the detection limit of 0.01 mg/L.

The total phosphorus TSI's for March and April 1980 were high because of the abundance of phosphorus introduced to the epilimnion during fall turnover. These spring TSI's are not representative of the overall trophic status of Courthouse Lake, but they do display a seasonal trend that could be observed each year if the mixing from fall and spring turnover introduces adequate quantities of phosphorus to the epilimnion. Total-phosphorus TSI's decline during summer (fig. 10) as phytoplankton utilize available phosphorus in the epilimnion and carry much of it to the hypolimnion and bottom sediments in their dead cells.

Total phosphorus concentrations in August 1979 and June 1980 each yielded a TSI of 33.0. This value compares favorably with the TSI's for the Secchi-disk transparency and the chlorophyll a concentration in August 1979.

The concentration of total phosphorus in August 1980 was only 0.003 mg/L. This gave a TSI of 16, less than half of all but the April chlorophyll a TSI. Total phosphorus concentration is used as a TSI variable because it is the nutrient usually available in quantities low enough to be limiting to phytoplankton growth. If phosphorus was not limiting, the additional phosphorus would tend to raise the TSI to a value that would exceed the TSI's of the other two variables measured. The TSI's for the other variables in the sample seem to be accurate compared to other samples and the mean summer TSI of 35, excluding the total phosphorus sample. This suggests that the total phosphorus concentration in the sample collected in August 1980 may have been lower than the actual epilimnetic concentration. However, re-analysis of the sample verified the concentration of total phosphorus. Analysis of the vertical profile indicates that phytoplankton productivity is limited to an unusually narrow range in depth. The August 1980 phosphorus sample may not have included a representative part of the epilimnetic waters because most of the phosphorus in the epilimnion is probably contained in the cells of these phytoplankton.

Measurements of Secchi-disk transparency obtained from the Minnesota Department of Natural Resources (written commun., 1980) provide a historical perspective of the trophic status of Courthouse Lake. Figure 11 shows the TSI's derived from these measurements. Included is the TSI for one surface sample of total phosphorus obtained on July 11, 1967.

The 1964 and 1967 TSI's were more than 50 and the total phosphorus TSI was near 60. This indicates that additional unutilized phosphorus may have been available in the epilimnion for phytoplankton growth. The TSI declined to almost 40 by 1968.

The TSI increased substantially in 1969 to more than 62. The following measurements show a rather steady decline to values less than 40 in 1977 and 1978.

Courthouse Lake was flooded by the Minnesota River in 1952, 1953, 1965, and 1969 (Minnesota Department of Natural Resources, written commun., 1980). The apparent effects of the contamination of Courthouse Lake by the floodwater, which contained 0.66 mg/L total phosphorus near Jordan on March 14, 1977 (U.S. Geological Survey, 1978), are shown in 1967 and 1969 by the increased Secchi-disk TSI's. The reduction in TSI's following the contamination indicates that Courthouse Lake is capable of assimilating the load of phosphorus by holding the phosphorus in the bottom sediments.

DESCRIPTION OF THE PROPOSED FLOOD-CONTROL PROJECT

The Chaska flood-control project proposed by the U.S. Army Corps of Engineers involves modification of a city-owned levee and construction of a new levee to protect the city of Chaska from high-water levels on the Minnesota River (fig. 12). Courthouse Lake will be behind this levee and will be protected from high-water levels on the Minnesota River up to the 100-year frequency elevation (H. A. Nelson, St. Paul District Corps of Engineers, written commun., 1981).

During high water on the Minnesota River, the flow of East and Chaska Creeks will be diverted east and west of the city, respectively (fig. 12). High flows on the creeks (greater than 200 ft^3/s on East Creek) will also be diverted away from the city. Potential flooding from the internal drainage of four subareas of the East and Chaska Creek watersheds below the diversion points will be controlled by ponding areas, gravity outlets through the levee, and a pumping station.

Runoff from 1,070 acres of the East Creek watershed below the diversion point will be directed into a natural depression and the creek channel behind the levee adjacent to Courthouse Lake. The runoff will discharge to the Minnesota River through a gravity outlet in the levee designed to convey more water than expected from the 100-year rainfall-runoff event.

A flap-gate in the gravity outlet will prevent the inflow of Minnesota River floodwaters, but will allow discharge from the ponding area when the water level is at least 1 foot above the elevation of the river. A combined frequency analysis by the Corps, incorporating the characteristics of the watershed, ponding area, and Minnesota River, indicates that the ponding area will have sufficient capacity to contain slightly more than the coincidental 100-year flood.

Should the volume and rate of interior runoff from the 1,070-acre subarea of Chaska exceed the ponding area capacity, an emergency overflow structure at an altitude of 714 feet (National Geodetic Vertical Datum of 1929) will direct the excess runoff into Courthouse Lake. The lake has a usable capacity of 186 acre-feet for runoff storage from the normal elevation of 703 to 714 feet (Barr, 1979).

Effects on Courthouse Lake

Runoff from the Chaska subarea could contain many constituents that might alter the present quality of Courthouse Lake. Excessive concentrations of phosphorus are frequently associated with nuisance phytoplankton blooms in lakes and phosphorus seems to be the nutrient occurring in concentrations low enough to be limiting to phytoplankton growth in Courthouse Lake. Phosphorus is commonly a constituent of runoff (M. A. Ayers, oral commun., 1981) and its typical effects on lake quality are well documented and mathematically quantified (Wetzel, 1975).

To evaluate the impact of a large phosphorus load on Courthouse Lake, it will be assumed that the flap-gate is completely closed, allowing none of the runoff to discharge to the river. The proposed project will not be implemented for some time, and because land use in the subarea will determine the quality of runoff received by the lake, the projected development will be used to characterize the Chaska subarea.

The projected development in the 1,070-acre subarea of Chaska by the year 2030 indicates that land use will consist of about 10 pecent of the area in schools, offices, industries, and retail stores, 42 percent in residential area, and 48 percent in park space and undeveloped area (Economics Section, St. Paul District Corps of Engineers, written commun., 1979). Assuming 70 percent of the area in schools, offices, etc., is impervious surface, 30 percent of the residential area is impervious, and none of the undeveloped areas are impervious, a total of about 20 percent of the total watershed can be considered to be impervious. The relief of the watershed was determined from the U.S. Geological Survey 7.5-minute topographic map to be about 225 feet.

No data are available to characterize the quality of runoff from the Chaska watershed, but the quality of runoff from a similar watershed was determined by Ayers and others (1980). The watershed, named State Highway 100 Storm Sewer, is located in Hennepin County and has a drainage area of approximately 301 acres, about 26 percent of which is considered to be impervious. The relief of the watershed is about 45 feet.

Data from the State Highway 100 watershed were examined and the storm producing the largest phosphorus load, which occurred on July 24-25, 1980, was chosen as a basis for estimating the phosphorus load from a hypothetical storm in the Chaska watershed. The 1.03 inches of rain recorded by a gage at the State Highway 100 site resulted in 0.23 inches or 5.77 acre-feet of runoff, which contained a total of 2.73 kilograms of phosphorus. Assuming that runoff from the Chaska watershed after development would be roughly equivalent to runoff from the State Highway 100 watershed, an equivalent storm in the larger Chaska watershed would produce 20.5 acre feet of runoff containing 9.70 kilograms of phosphorus. The initial concentration of phosphorus in the temporary pond, capacity 34 acre feet, adjacent to Courthouse Lake would, therefore, be 0.384 mg/L.

To estimate the impact of a large runoff on Courthouse Lake, assume that enough additional runoff from the hypothetical storm is routed through the pond to fill the lake to the same level as the pond, 714 feet. The three final samplings of the July 1980 storm at Highway 100 had an average phosphorus concentration of 0.24 mg/L. Assuming that this would be the phosphorus concentration in sustained runoff from the hypothetical Chaska storm, an additional 199.5 acre-feet of this water would amount to 220 acre-feet of runoff in the pond and lake combined, with an average phosphorus concentration of 0.25 mg/L.

Some of the phosphorus and other constituents in the runoff will generally have time to settle out before the water enters the lake because runoff from the Chaska watershed will fill the pond before spilling into Courthouse Lake. The quantity of phosphorus lost in this way will depend on the rate at which the pond and lake are filled with runoff. It is assumed that no phosphorus is lost to settling in the high-intensity storm considered here.

Adding 186 acre-feet of this runoff to the 261-acre-foot volume of the lake at normal elevation (Minnesota Department of Natural Resources, written commun., 1980) having the spring concentration of 0.03 mg/L total phosphorus, would fill the lake basin to a 447 acre-foot volume containing 0.12 mg/L total phosphorus, assuming the waters mix completely. After the recession of the Minnesota River, the lake will be drained to its original elevation and volume leaving about an additional 0.09 mg/L total phosphorus in Courthouse Lake.

The impact of this phosphorus load on the lake is uncertain, but it is estimated that Carlson's (1977) trophic state index (TSI) for total phosphorus would increase from 49 to 69. Assuming TSI's for phosphorus and Secchi-disk transparency are interchangeable, the calculated Secchi-disk transparency would be 0.54 meter. Measured Secchi-disk transparencies were as low as 0.8 meter after flooding of Courthouse Lake by the Minnesota River (Department of Natural Resources, written commun., 1980). The total phosphorus concentration in the lake calculated from the TSI for this September 1969 measurement would have been about 0.08 mg/L. The actual input of phosphorus from the river to the lake cannot be determined, however, the concentration of total phosphorus in the Minnesota River during spring 1977 was 0.66 mg/L (U.S. Geological Survey, 1978). The recovery of Courthouse Lake from phosphorus introduced by the Minnesota River indicates that the lake should easily assimilate periodic phosphorus loading in runoff from the Chaska area.

SUMMARY AND CONCLUSIONS

Water-quality samples were collected for 1 year from East Creek, Chaska Creek, and Courthouse Lake in Chaska, Minn. This report defines the quality of these waters and evaluates the potential effects of a flood-control project proposed by the U.S. Army Corps of Engineers.

The creeks had similar water-quality characteristics with mean pH values of 7.9 and DO concentrations that were nearly saturated throughout the year. The mean specific conductance of Chaska Creek, 652 umhos/cm, was slightly higher than the mean specific conductance of East Creek, 610 umhos/cm.

Concentrations of dissolved solids, sulfate, and chloride were associated with base flow in the creeks, and were probably introduced from ground water. Chromium concentrations of about 22 ug/L found in base flow were probably also introduced from ground water.

Organic carbon, BOD, and many forms of nitrogen and phosphorus had concentrations that were generally highest during runoff. Concentrations of oil and grease and most metals were also higher in runoff.

Pesticide samples detected alachlor, atrazine, simazine, and 2,4-D in both creeks. Chaska Creek had the highest concentration of these pesticides.

Vertical profiles show that Courthouse Lake develops thermal stratification with an indistinct thermocline and temperatures that range as much as 19°C from surface to bottom. The hypolimnion was anoxic in August 1979, which could allow the release of soluble phosphates from the lake sediments.

Calcium, silica, phosphorus, and nitrogen concentrations and alkalinity became depleted in the epilimnion of the lake relative to the hypolimnetic concentrations. This was apparently the result of biological activity, which should not cause the observed variations in organic carbon and sodium concentrations.

Phytoplankton populations varied seasonally during the sampling. Diatoms and cryptomonads were predominant in winter and spring, and blue-green algae were predominant in late summer. Green algae were present throughout the year, and were dominant in early summer. The genera of phytoplankton identified did not provide evidence of high organic pollution in Courthouse Lake.

Courthouse Lake had a mean summer trophic state index of 35. Trophic state indices from past measurements of Secchi-disk transparency indicate that Courthouse Lake has recovered from flood waters of the Minnesota River with total phosphorus concentrations as high as 0.66 mg/L.

The recovery of Courthouse Lake from flooding suggests that the lake will also recover from the possible input of phosphorus expected as a result of implementing the flood-control project planned by the Corps. The runoff could raise the total phosphorus concentration from 0.03 to 0.12 mg/L, raising the spring trophic state index from 49 to 69.

Depending on the quality and volume of runoff received by the lake, a temporary decline in the recreational and esthetic value of the lake, including destruction of the trout fishery, could result.

Should Courthouse Lake receive appreciable amounts of runoff following implementation of the proposed flood-control project, interested persons may wish to monitor the trophic variables in the lake and determine the quality of the runoff water. This would provide a basis for determining what, if any, detrimental effects could be expected from the runoff inputs to the lake.

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WATER-QUALITY DATA

[illegible] WATER-QUALITY DATA

[illegible] CREEK AT [illegible]ACKA, MN

DATE	TIME	STREAM-FLOW, INSTANTANEOUS (CFS)	SPECIFIC CONDUCTANCE	PH (UNITS)	TEMPERATURE (DEG C)	TURBIDITY (NTU)	OXYGEN, DISSOLVED (MG/L)	OXYGEN, DISSOLVED (PERCENT SATURATION)	OXYGEN DEMAND, BIOCHEMICAL, 5 DAY (MG/L)
AUG, [illegible]									
[illegible]...	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEP									
[illegible]...	11[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]									
[illegible]...	111[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JAN, 19[illegible]									
1[illegible]...	11[illegible]	1.4	1[illegible]	[illegible]	[illegible]	[illegible]	11.[illegible]	[illegible]	[illegible]
MAR									
[illegible]...	1[illegible]00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1[illegible]	[illegible]	--
APR									
[illegible]...	[illegible]	[illegible].9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--
MAY									
[illegible]...	11[illegible]	1.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1[illegible].1	[illegible]	[illegible]
JUN									
1[illegible]...	1[illegible]	4.[illegible]	[illegible]	[illegible]	17.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8...	1[illegible]4[illegible]	[illegible]	491	[illegible]	17.[illegible]	1[illegible]	[illegible]	[illegible]	--
JUL									
17...	1115	.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	[illegible]
[illegible]...	1445	.51	--	--	--	--	--	--	--
AUG									
[illegible]...	1310	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE [illegible].--WATER-QUALITY DATA--Continued

[illegible] - [illegible] CREEK AT [illegible], MN--Continued

DATE	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, RESIDUE AT 105 DEG. C, SUS-PENDED (MG/L)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N)	NITRO-GEN, ORGANIC TOTAL (MG/L AS N)
AUG , 1979									
30...	--	20	[illegible]	19	.1	--	[illegible]	--	[illegible]
SEP									
27...	[illegible]	28	[illegible]	[illegible]	--	[illegible]	--	--	--
OCT									
30...	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	--	[illegible]	--
JAN , 1980									
18...	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	--	[illegible]	--
MAR									
[illegible]...	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	--	[illegible]	--
APR									
[illegible]...	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	--	[illegible]	--
MAY									
[illegible]...	[illegible]	[illegible]	[illegible]	11	--	[illegible]	--	[illegible]	--
[illegible]									
[illegible]...	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	--	[illegible]	--
[illegible]...	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	--	[illegible]	--
[illegible]									
[illegible]...	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	--	[illegible]	--
[illegible]...	--	--	--	--	--	--	--	--	--
[illegible]									
[illegible]...	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	--	[illegible]	--

[illegible]--[illegible] DATA--Continued

[illegible] AT [illegible]KA, MN--Continued

[illegible]	NITRO-GEN, [illegible] (MG/L AS N)	NITRO-GEN, AMMONIA + ORGANIC [illegible] (MG/L AS N)	NITRO-GEN, AMMONIA + ORGANIC [illegible] (MG/L AS N)	NITRO-GEN, [illegible] (MG/L AS N)	NITRO-GEN, [illegible] (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)	CARBON, ORGANIC DIS-SOLVED (MG/L AS C)	CARBON, ORGANIC SUS-PENDED TOTAL (MG/L AS C)
[illegible]	--	[illegible]	[illegible]	[illegible]	--	[illegible]	.020	13	1.5
[illegible]	--	[illegible]	[illegible]	--	[illegible]	[illegible]	.020	3.4	.5
[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	[illegible]	.030	12	1.2
[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	[illegible]	.040	10	.5
[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	[illegible]	.260	12	2.3
[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	.030	.020	12	.4
[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	.090	.060	11	.5
[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	.130	.060	13	1.4
[illegible]	[illegible]	--	[illegible]	--	.91	.080	.060	11	.3
[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	.050	.050	4.2	.5
[illegible]	--	--	--	--	--	--	--	--	--
[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	.010	.010	3.6	.4

TABLE [illegible].--WATER-QUALITY DATA--Continued

[illegible] - EAST CREEK AT CHASKA, MN--Continued

DATE	TIME	ARSENIC TOTAL (UG/L AS AS)	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD)	CHRO-MIUM, TOTAL RECOV-ERABLE (UG/L AS CR)	COPPER, TOTAL RECOV-ERABLE (UG/L AS CU)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE)	LEAD, TOTAL RECOV-ERABLE (UG/L AS PB)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN)	MERCURY TOTAL RECOV-ERABLE (UG/L AS HG)	ZINC, TOTAL RECOV-ERABLE (UG/L AS ZN)
MAR [illegible]										
[illegible]...	[illegible]	[illegible]	[illegible]	1	4	1400	130	400	<.1	[illegible]
JUL										
[illegible]...	[illegible]	[illegible]	[illegible]	[illegible]	0	440	1	100	<.1	[illegible]

TABLE 3.--WATER-QUALITY DATA--Continued

444728093355201 - EAST CREEK AT CHASKA, MN--Continued

DATE	TIME	PCB, TOTAL (UG/L)	NAPH-THA-LENES, POLY-CHLOR. TOTAL (UG/L)	ALDRIN, TOTAL (UG/L)	ATRA-ZINE, TOTAL (UG/L)	CHLOR-DANE, TOTAL (UG/L)	DDD, TOTAL (UG/L)	DDE, TOTAL (UG/L)	DDT, TOTAL (UG/L)	DI-AZINON, TOTAL (UG/L)	DI-ELDRIN TOTAL (UG/L)
JUN , 1980											
12...	1010	.00	.00	.00	.40	.00	.00	.00	.00	.00	.00

DATE	ENDO-SULFAN, TOTAL (UG/L)	ENDRIN, TOTAL (UG/L)	ETHION, TOTAL (UG/L)	HEPTA-CHLOR, TOTAL (UG/L)	HEPTA-CHLOR EPOXIDE TOTAL (UG/L)	LINDANE TOTAL (UG/L)	MALA-THION, TOTAL (UG/L)	METH-OXY-CHLOR, TOTAL (UG/L)	METHYL PARA-THION, TOTAL (UG/L)	METHYL TRI-THION, TOTAL (UG/L)	MIREX, TOTAL (UG/L)
JUN , 1980											
12...	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

DATE	PARA-THION, TOTAL (UG/L)	PER-THANE TOTAL (UG/L)	PROME-TONE TOTAL (UG/L)	PROME-TRYNE TOTAL (UG/L)	SILVEX, TOTAL (UG/L)	SIMA-ZINE TOTAL (UG/L)	SIME-TRYNE TOTAL (UG/L)	TOX-APHENE, TOTAL (UG/L)	TOTAL TRI-THION (UG/L)	2,4-D, TOTAL (UG/L)	2,4,5-T TOTAL (UG/L)
JUN , 1980											
12...	.00	.00	.0	.0	.00	.060	.0	0	.00	.07	.00

TABLE 3.--WATER-QUALITY DATA--Continued

05330700 - CHASKA CREEK AT CHASKA, MN

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	PH (UNITS)	TEMPER-ATURE (DEG C)	TUR-BID-ITY (NTU)	OXYGEN, DIS-SOLVED (MG/L)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION)	OXYGEN DEMAND, BIO-CHEM-ICAL, 5 DAY (MG/L)
AUG , 1979									
30...	1430	11	548	8.0	19.6	15	8.7	97	2.2
SEP									
27...	1200	1.7	740	8.3	15.5	2.0	10.6	109	1.2
OCT									
30...	1330	3.3	720	8.3	10.0	4.0	10.6	94	1.7
JAN , 1980									
14...	1250	1.6	783	7.9	1.5	1.1	13.6	99	--
MAR									
25...	1500	24	327	7.5	2.4	50	14.1	106	--
APR									
30...	1400	3.2	638	8.3	17.1	.65	12.0	126	2.1
MAY									
30...	1300	1.7	724	7.7	15.2	9.0	9.1	92	3.8
JUN									
12...	1145	11	684	7.7	16.8	28	9.4	99	--
24...	0915	2.4	589	8.2	20.0	1.0	--	--	1.9
JUL									
17...	1015	.99	686	8.2	29.0	4.5	8.2	108	--
23...	1600	.51	--	--	--	--	--	--	.8
AUG									
22...	1130	1.2	729	7.7	16.5	2.6	11.3	116	1.0

TABLE 3.--WATER-QUALITY DATA--Continued

05330700 - CHASKA CREEK AT CHASKA, MN--Continued

DATE	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	SOLIDS, RESIDUE AT 105 DEG. C, SUS- PENDED (MG/L)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)	NITRO- GEN, AMMONIA TOTAL (MG/L AS N)	NITRO- GEN, AMMONIA DIS- SOLVED (MG/L AS N)	NITRO- GEN, ORGANIC TOTAL (MG/L AS N)
AUG , 1979									
30...	--	16	384	50	1.6	--	.080	--	1.5
SEP									
27...	39	19	327	1	--	.63	--	--	--
OCT									
30...	38	20	458	11	--	1.2	--	.010	--
JAN , 1980									
14...	45	21	456	21	--	2.0	--	.170	--
MAR									
25...	17	14	229	60	--	.94	--	1.50	--
APR									
30...	37	21	473	15	--	.19	--	.010	--
MAY									
30...	34	23	487	860	--	.50	--	.110	--
JUN									
12...	27	18	368	76	--	1.1	--	.100	--
24...	19	21	435	15	--	.70	--	.070	--
JUL									
17...	53	28	432	16	--	.31	--	.130	--
23...	--	--	--	--	--	--	--	--	--
AUG									
22...	39	18	439	8	--	.31	--	.030	--

TABLE 3.--WATER-QUALITY DATA--Continued

05330700 - CHASKA CREEK AT CHASKA, MN--Continued

DATE	NITRO-GEN, ORGANIC DIS-SOLVED (MG/L AS N)	NITRO-GEN,AM-MONIA + ORGANIC TOTAL (MG/L AS N)	NITRO-GEN,AM-MONIA + ORGANIC DIS. (MG/L AS N)	NITRO-GEN, TOTAL (MG/L AS N)	NITRO-GEN, DISSOLV (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)	CARBON, ORGANIC DIS-SOLVED (MG/L AS C)	CARBON, ORGANIC SUS-PENDED TOTAL (MG/L AS C)
AUG , 1979									
30...	--	1.60	1.6	3.2	--	.280	.220	15	.8
SEP									
27...	--	.61	.61	--	1.2	.080	.060	7.7	.5
OCT									
30...	.91	.92	.92	--	2.1	.080	.060	12	.4
JAN , 1980									
14...	.74	.91	.91	--	2.9	.070	.050	5.4	.2
MAR									
25...	1.7	4.30	3.2	--	4.1	.480	.460	18	4.2
APR									
30...	.82	1.00	.83	--	1.0	.130	.060	11	.6
MAY									
30...	.51	.62	.62	--	1.1	.170	.110	9.3	.5
JUN									
12...	1.4	1.30	1.5	--	2.6	.450	.270	18	3.[illegible]
24...	.44	--	.51	--	1.2	.240	.190	15	.5
JUL									
17...	.21	.42	.34	--	.65	.080	.050	[illegible].8	.4
23...	--	--	--	--	--	--	--	--	--
AUG									
22...	.29	.45	.32	--	.63	.050	.050	4.1	.4

TABLE 3.--WATER-QUALITY DATA--Continued

05330700 - CHASKA CREEK AT CHASKA, MN--Continued

DATE	TIME	ARSENIC TOTAL (UG/L AS AS)	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD)	CHRO-MIUM, TOTAL RECOV-ERABLE (UG/L AS CR)	COPPER, TOTAL RECOV-ERABLE (UG/L AS CU)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE)	LEAD, TOTAL RECOV-ERABLE (UG/L AS PB)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN)	MERCURY TOTAL RECOV-ERABLE (UG/L AS HG)	ZINC, TOTAL RECOV-ERABLE (UG/L AS ZN)
MAR , 1980										
25...	1500	7	0	1	6	3100	4	670	<.1	30
JUL										
17...	1015	4	0	22	1	670	0	340	<.1	10

TABLE 3.--WATER-QUALITY DATA--Continued

05330700 - CHASKA CREEK AT CHASKA, MN--Continued

DATE	TIME	PCB, TOTAL (UG/L)	NAPH-THA-LENES, POLY-CHLOR. TOTAL (UG/L)	ALDRIN, TOTAL (UG/L)	ATRA-ZINE, TOTAL (UG/L)	CHLOR-DANE, TOTAL (UG/L)	DDD, TOTAL (UG/L)	DDE, TOTAL (UG/L)	DDT, TOTAL (UG/L)	DI-AZINON, TOTAL (UG/L)	DI-ELDRIN TOTAL (UG/L)
JUN , 1980											
12...	1145	.00	.00	.00	3.3	.00	.00	.00	.00	.00	.00

DATE	ENDO-SULFAN, TOTAL (UG/L)	ENDRIN, TOTAL (UG/L)	ETHION, TOTAL (UG/L)	HEPTA-CHLOR, TOTAL (UG/L)	HEPTA-CHLOR EPOXIDE TOTAL (UG/L)	LINDANE TOTAL (UG/L)	MALA-THION, TOTAL (UG/L)	METH-OXY-CHLOR, TOTAL (UG/L)	METHYL PARA-THION, TOTAL (UG/L)	METHYL TRI-THION, TOTAL (UG/L)	MIREX, TOTAL (UG/L)
JUN , 1980											
12...	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

DATE	PARA-THION, TOTAL (UG/L)	PER-THANE TOTAL (UG/L)	PROME-TONE TOTAL (UG/L)	PROME-TRYNE TOTAL (UG/L)	SILVEX, TOTAL (UG/L)	SIMA-ZINE TOTAL (UG/L)	SIME-TRYNE TOTAL (UG/L)	TOX-APHENE, TOTAL (UG/L)	TOTAL TRI-THION (UG/L)	2,4-D, TOTAL (UG/L)	2,4,5-T TOTAL (UG/L)
JUN , 1980											
12...	.00	.00	.0	.0	.00	.050	.0	0	.00	.09	.00

WATER-QUALITY DATA

444720093352401 - COURTHOUSE LAKE AT CHASKA, MN

DATE	TIME	SAMPLING DEPTH (FT)	RESERVOIR DEPTH (FEET)	SPECIFIC CONDUCTANCE (UMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	TRANSPARENCY (SECCHI DISK) (M)	OXYGEN, DISSOLVED (MG/L)	OXYGEN, DISSOLVED (PERCENT SATURATION)	HARDNESS (MG/L AS CACO3)
AUG , 1979										
30...	1205	12	56	375	8.4	22.0	5.2	8.8	102	--
30...	1215	51	56	434	7.5	4.8	--	.1	8	--
MAR , 1980										
25...	1100	9.0	54	398	7.7	4.1	--	11.3	88	--
APR										
30...	1022	12	53	364	8.2	10.2	5.1	12.2	111	--
JUN										
24...	1020	3.0	47	370	8.0	25.0	--	8.5	104	--
AUG										
22...	0930	15	55	380	8.4	23.7	4.1	8.4	100	170
22...	1001	48	55	423	7.0	6.4	--	3.1	25	200

DATE	HARDNESS, NONCARBONATE (MG/L CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	ALKALINITY FIELD (MG/L AS CACO3)	SULFATE DISSOLVED (MG/L AS SO4)	CHLORIDE, DISSOLVED (MG/L AS CL)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)
AUG , 1979										
30...	--	--	--	--	--	--	--	10	--	--
30...	--	--	--	--	--	--	--	--	--	--
MAR , 1980										
25...	--	--	--	--	--	--	--	12	--	--
APR										
30...	--	--	--	--	--	--	--	10	--	--
JUN										
24...	--	--	--	--	--	120	46	10	.2	--
AUG										
22...	48	36	19	5.4	5.0	120	50	11	.3	.8
22...	37	46	20	10	5.1	160	48	12	.3	3.0

WATER-QUALITY DATA

444720093352401 - COURTHOUSE LAKE AT CHASKA, MN

DATE	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	SOLIDS, DIS- SOLVED (TONS PER AC-FT)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)	NITRO- GEN, AMMONIA TOTAL (MG/L AS N)	NITRO- GEN, AMMONIA DIS- SOLVED (MG/L AS N)	NITRO- GEN, ORGANIC TOTAL (MG/L AS N)	NITRO- GEN, ORGANIC DIS- SOLVED (MG/L AS N)	NITRO- GEN, AM- MONIA + ORGANIC TOTAL (MG/L AS N)
AUG , 1979										
30...	230	--	.31	.00	--	.01	--	.39	--	.40
30...	266	--	.36	.00	--	.67	--	.63	--	1.3
MAR , 1980										
25...	247	--	.34	--	.05	--	.07	--	.15	.23
APR										
30...	236	--	.32	--	.03	--	.00	--	.43	.60
JUN										
24...	247	--	.34	--	.01	--	.03	--	.05	.44
AUG										
22...	232	200	.32	--	.00	--	.00	--	.32	.35
22...	278	241	.38	--	.00	--	.11	--	.35	.54

DATE	NITRO- GEN, AM- MONIA + ORGANIC DIS. (MG/L AS N)	NITRO- GEN, TOTAL (MG/L AS N)	NITRO- GEN, DISSOLV (MG/L AS N)	PHOS- PHORUS, TOTAL (MG/L AS P)	PHOS- PHORUS, DIS- SOLVED (MG/L AS P)	CARBON, ORGANIC DIS- SOLVED (MG/L AS C)	CARBON, ORGANIC SUS- PENDED TOTAL (MG/L AS C)	PHYTO- PLANK- TON, TOTAL (CELLS PER ML)	CHLOR-A PHYTO- PLANK- TON CHROMO FLUOROM (UG/L)	CHLOR-B PHYTO- PLANK- TON CHROMO FLUOROM (UG/L)
AUG , 1979										
30...	.30	.40	--	.01	.01	7.1	.2	2000	1.26	.000
30...	1.3	1.3	--	.47	.43	--	--	--	--	--
MAR , 1980										
25...	.22	--	.27	.05	.03	5.8	.4	7100	--	--
APR										
30...	.43	--	.46	.03	.01	4.9	.3	0	.000	.000
JUN										
24...	.08	--	.09	.01	.01	5.9	.3	1400	--	--
AUG										
22...	.32	--	.32	.003	.000	4.8	.7	5200	1.69	.000
22...	.46	--	.46	.184	.177	9.6	.4	--	--	--

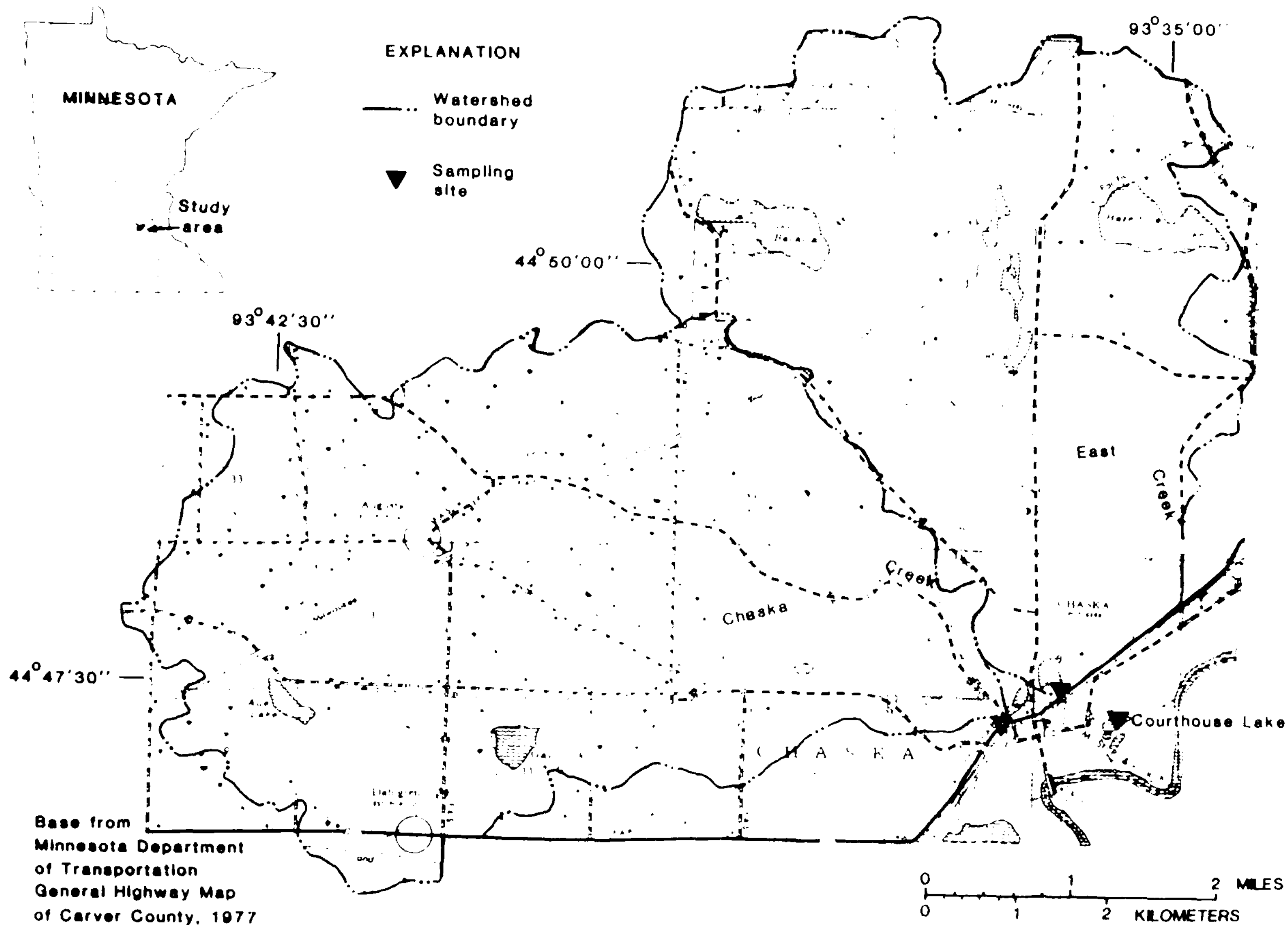


Figure 1. -- Location and setting of study area

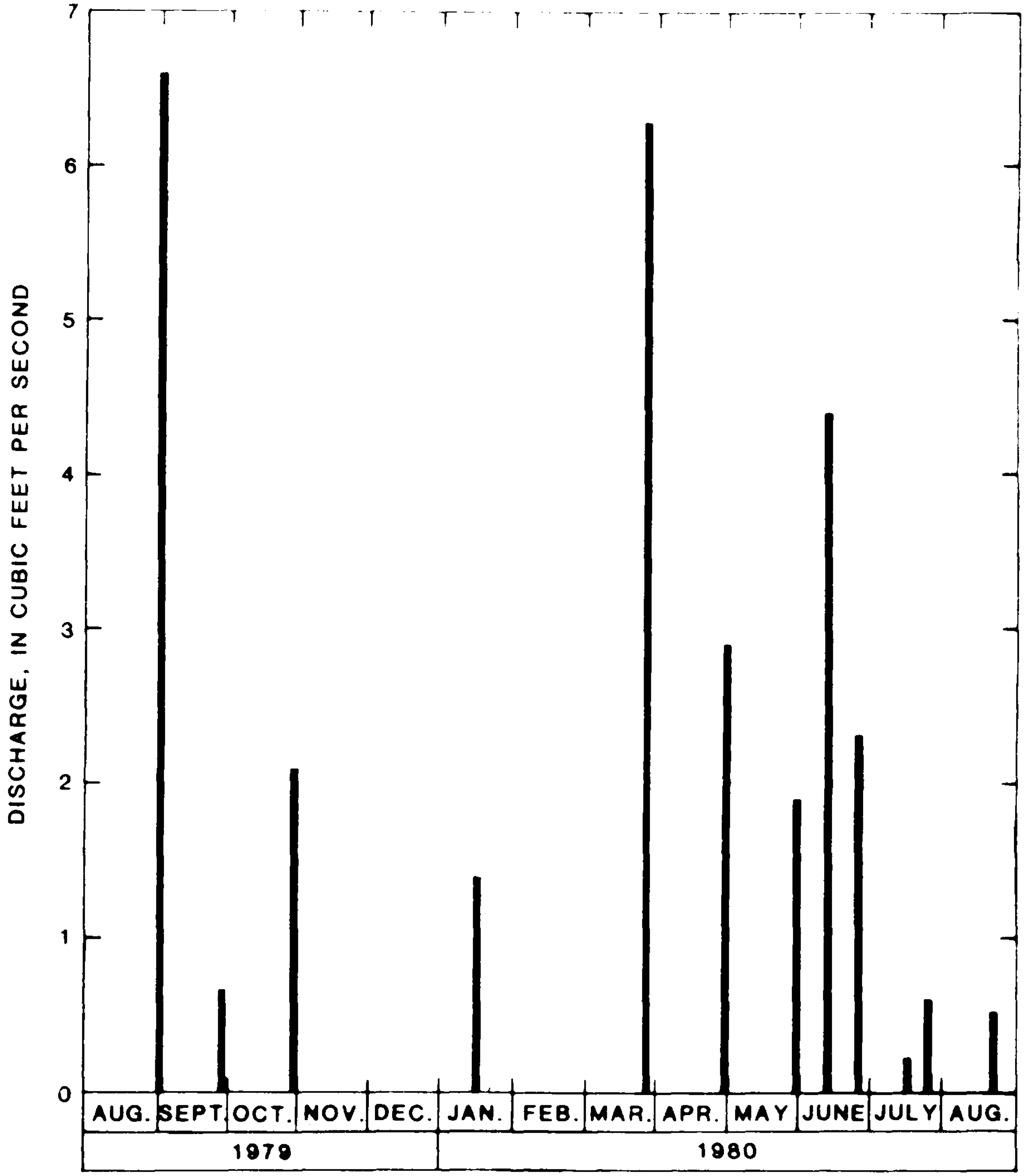


Figure 2.--Measurements of discharge at East Creek

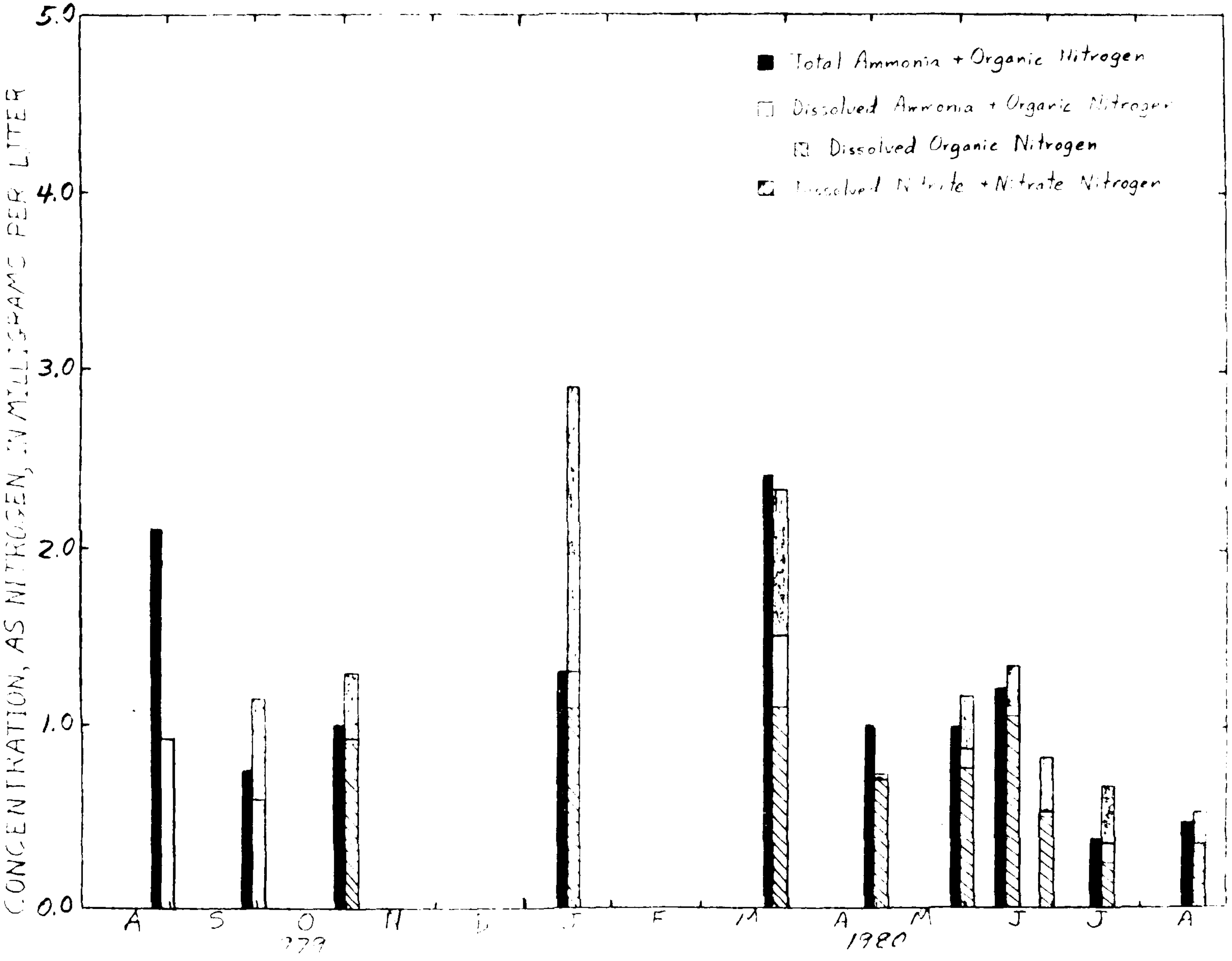


Figure 3.--Concentration of nitrogen forms in East Creek

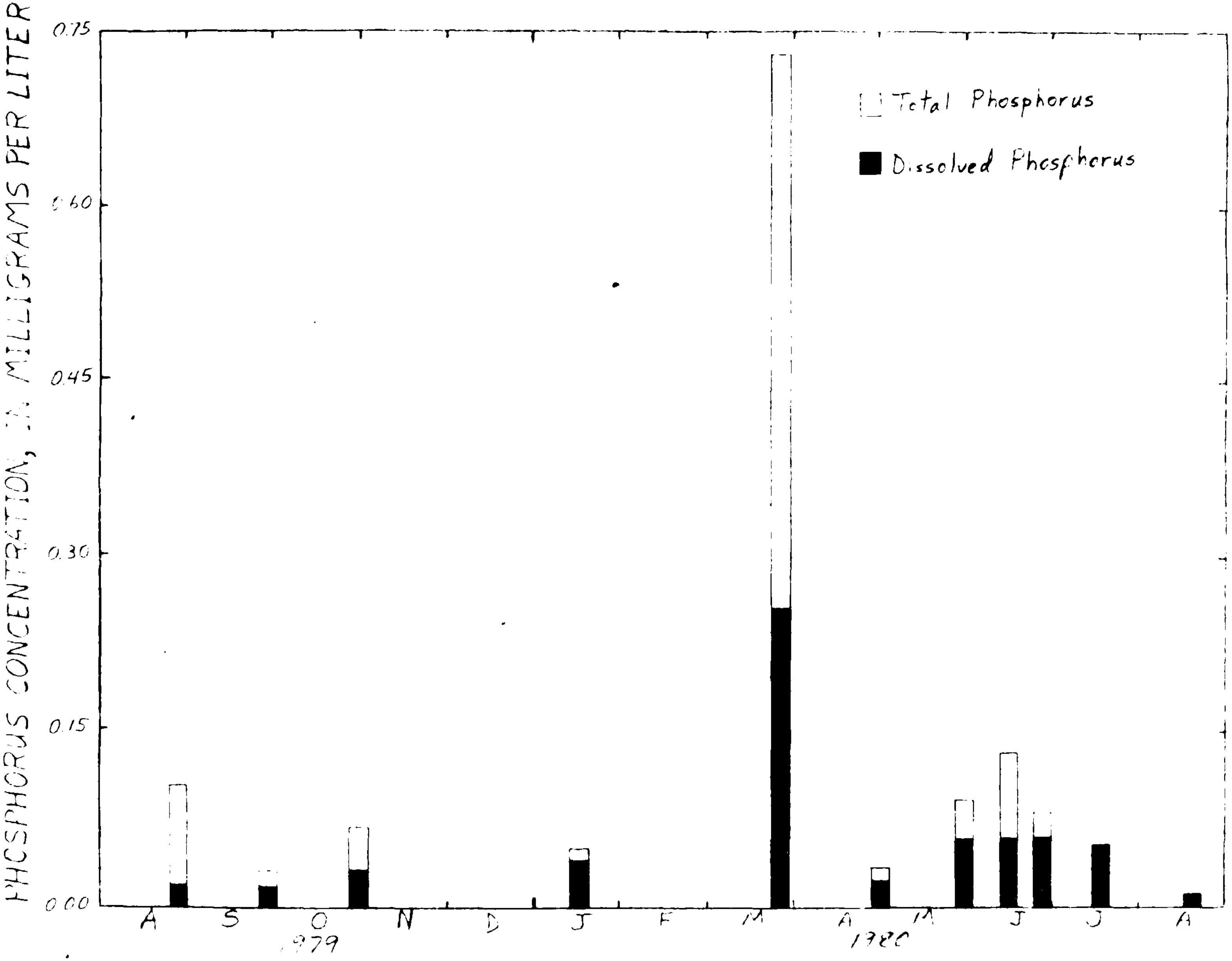


Figure 4.-- Concentrations of total and dissolved phosphorus in East Creek

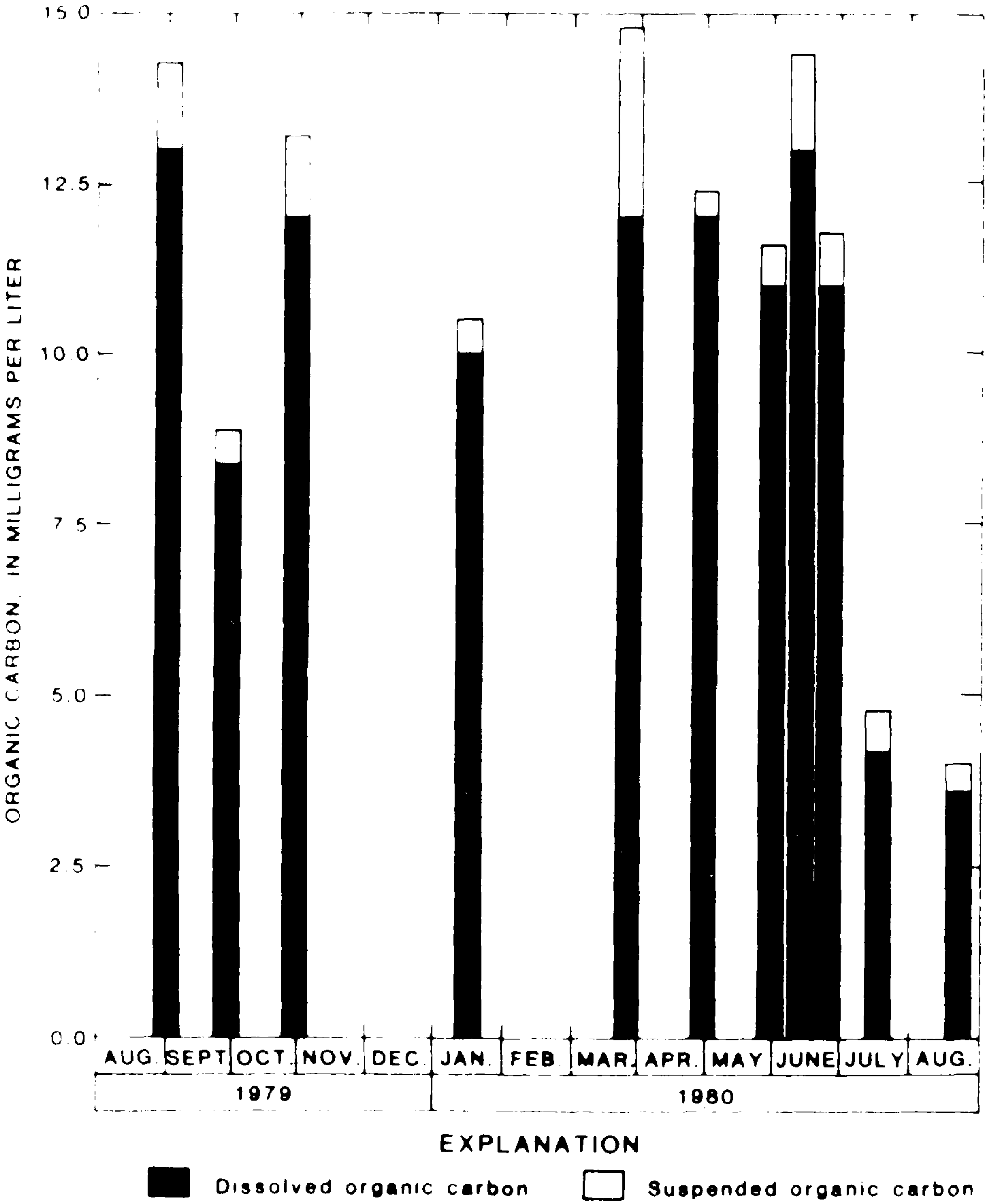


Figure 5.--Concentrations of organic carbon at East Creek

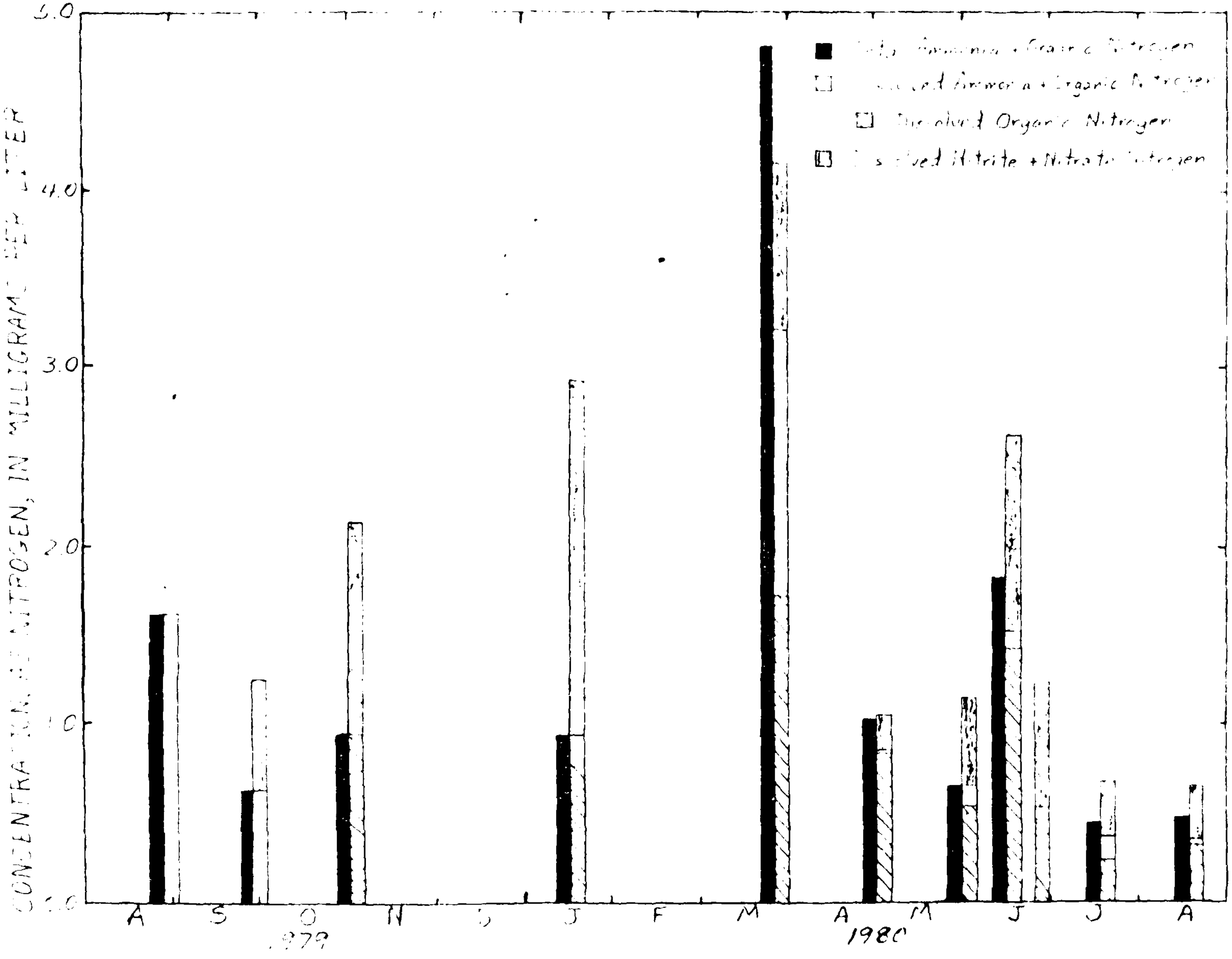
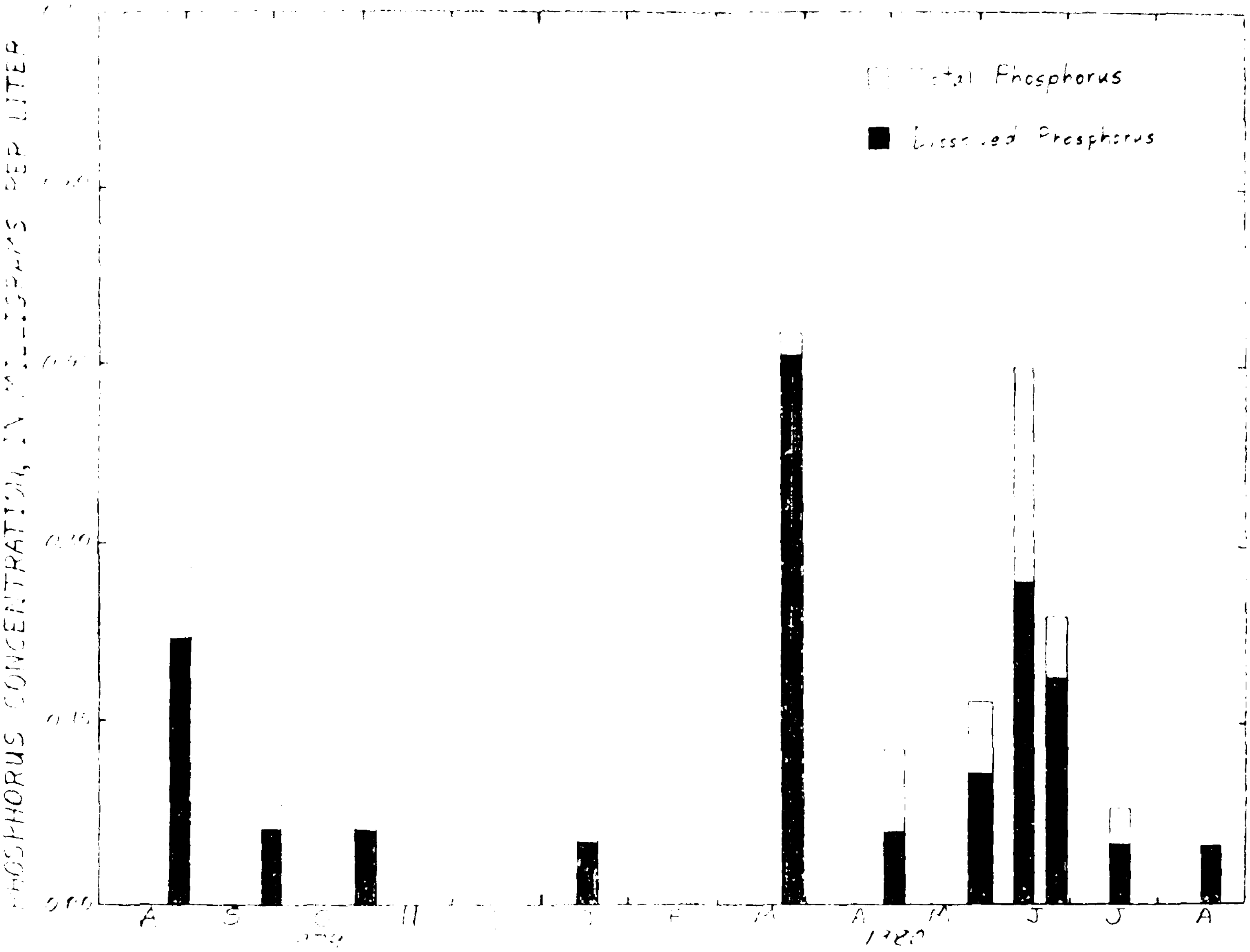


Figure 6.-- Concentration of nitrogen forms in Chaska Creek



... Phosphorus in Chacka Creek

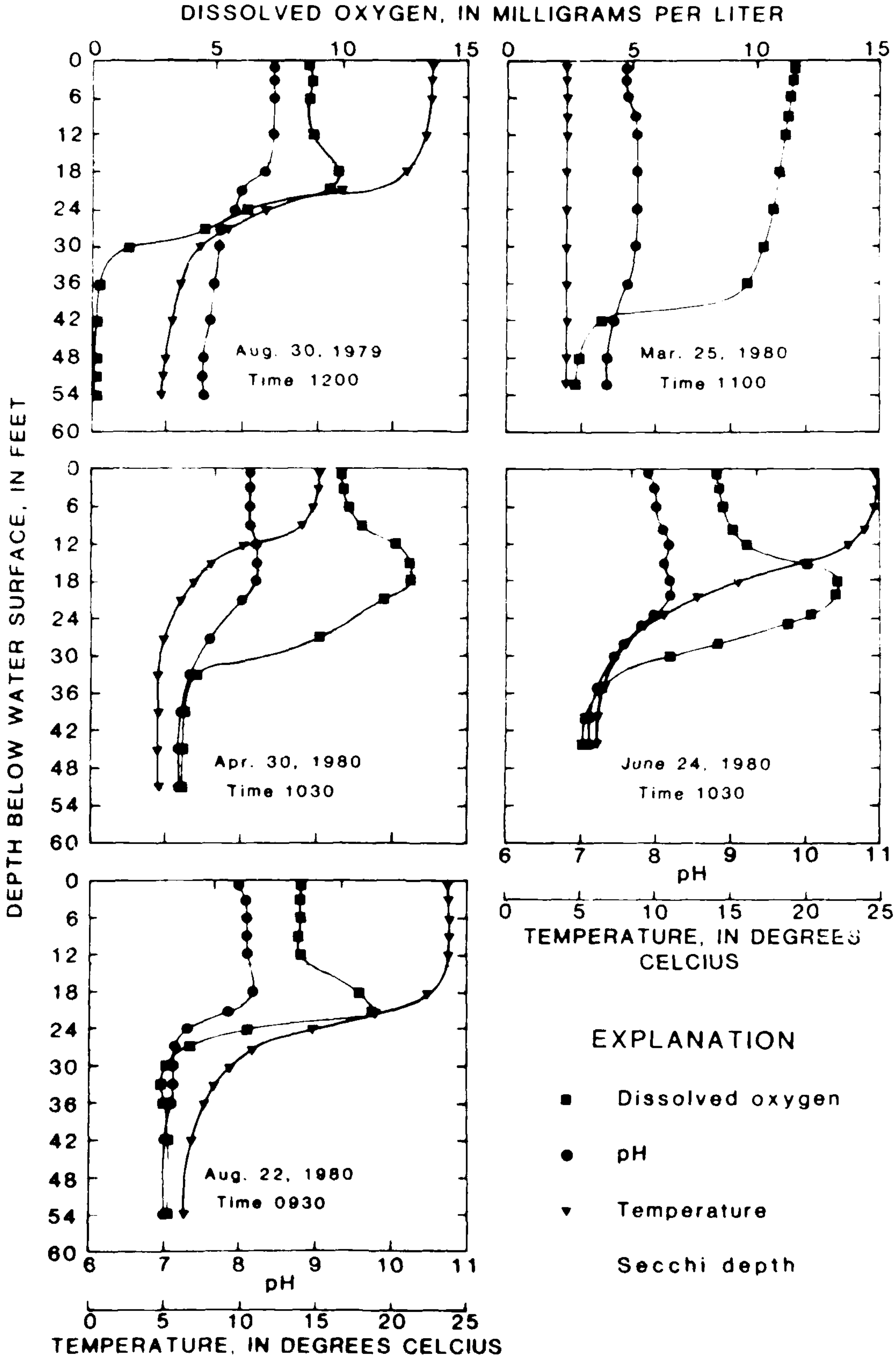


Figure 8.--Vertical profiles of Courthouse Lake

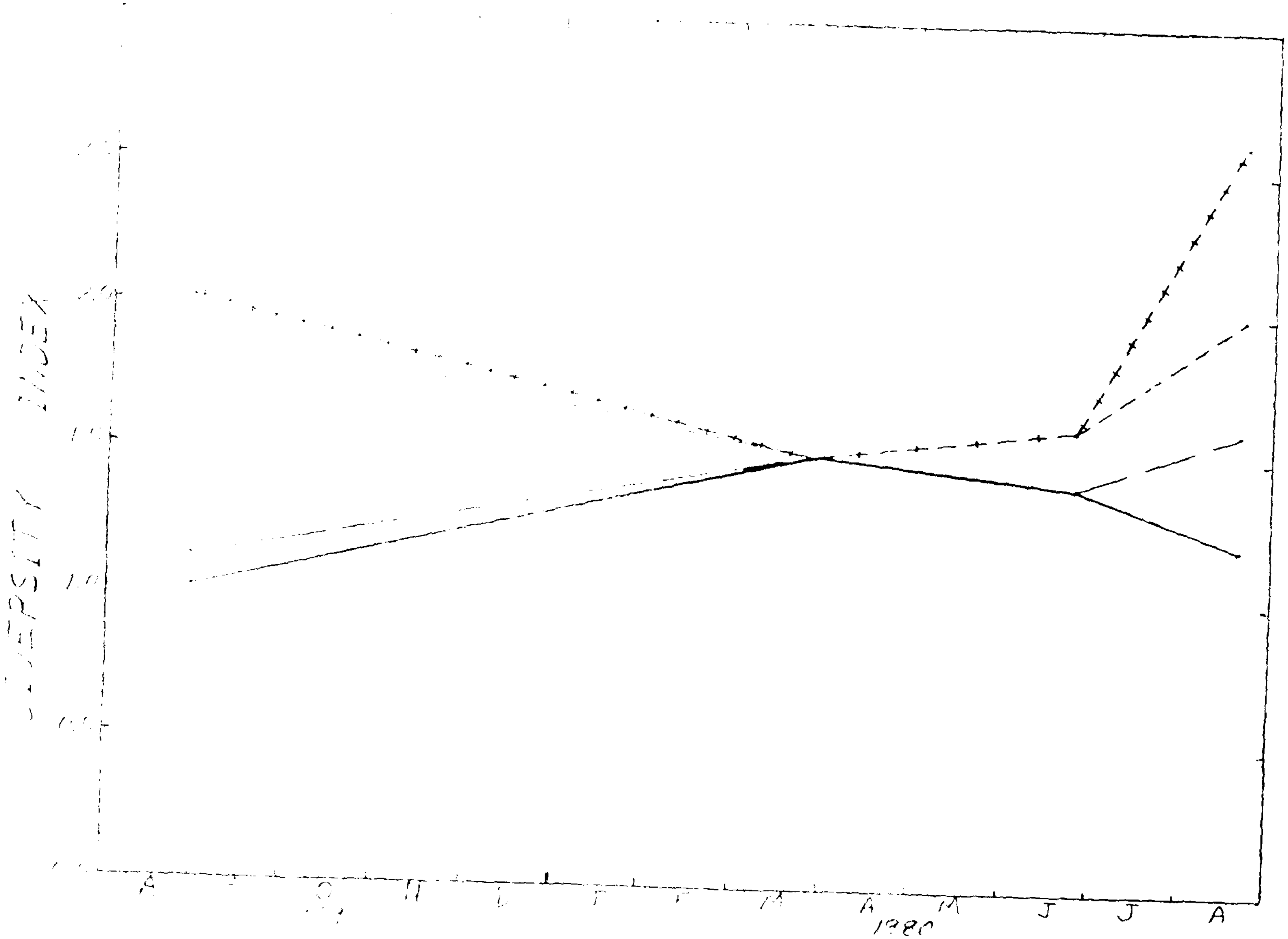
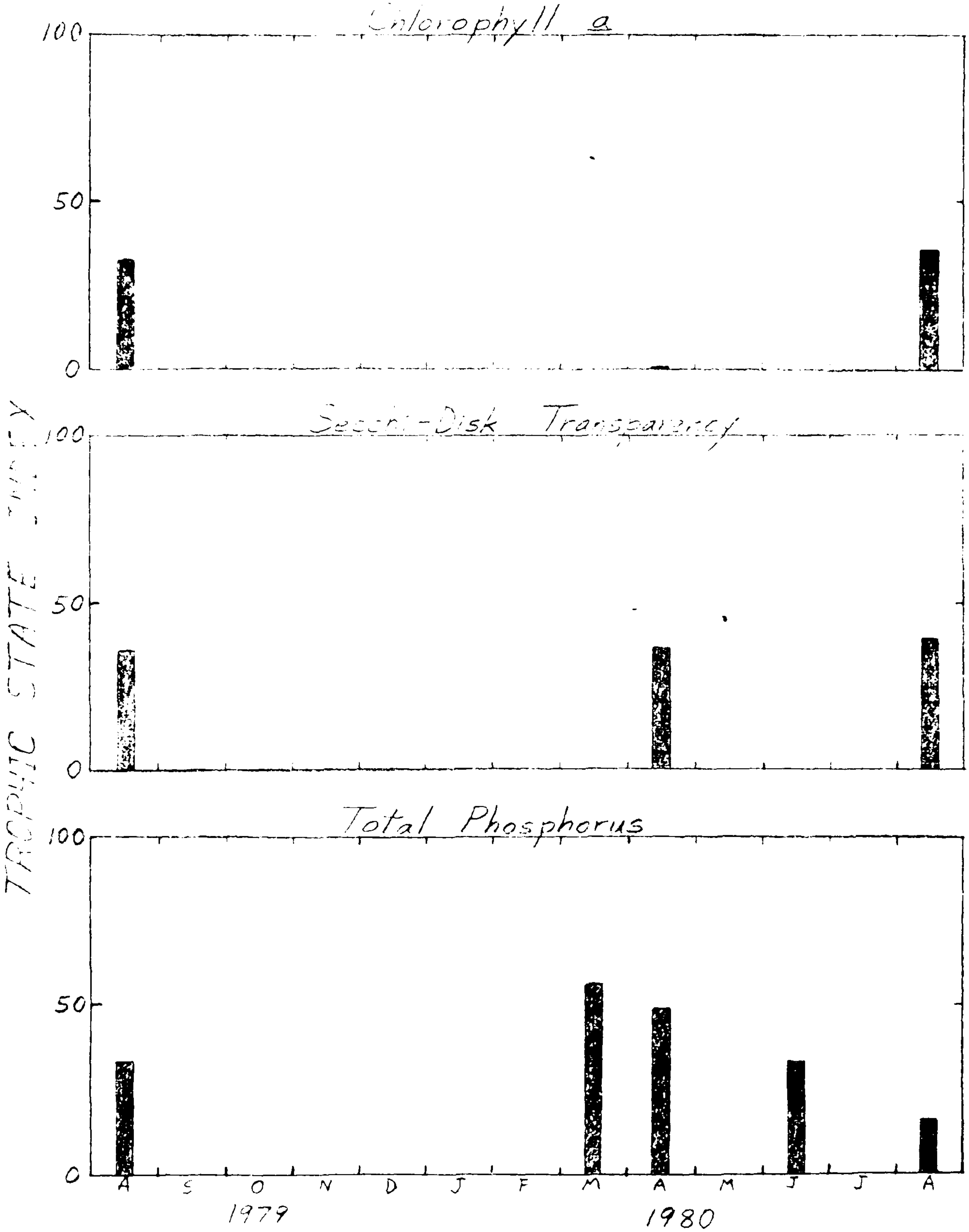


Figure [illegible]. Diversity indices for Courthouse Lake phytoplankton samples



for Courthouse Lake

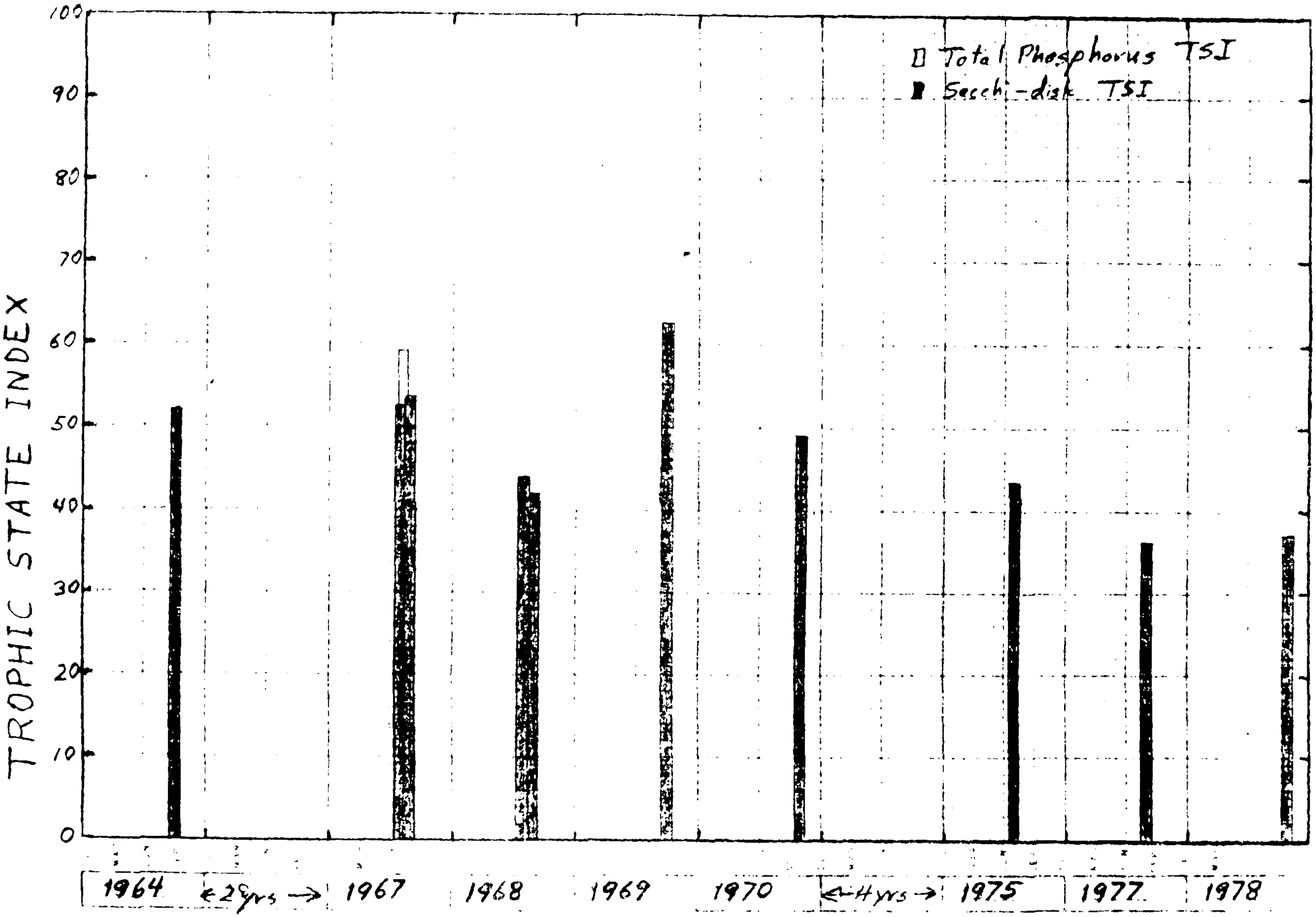


Figure 11.-- Historical trophic state indices for Courthouse Lake

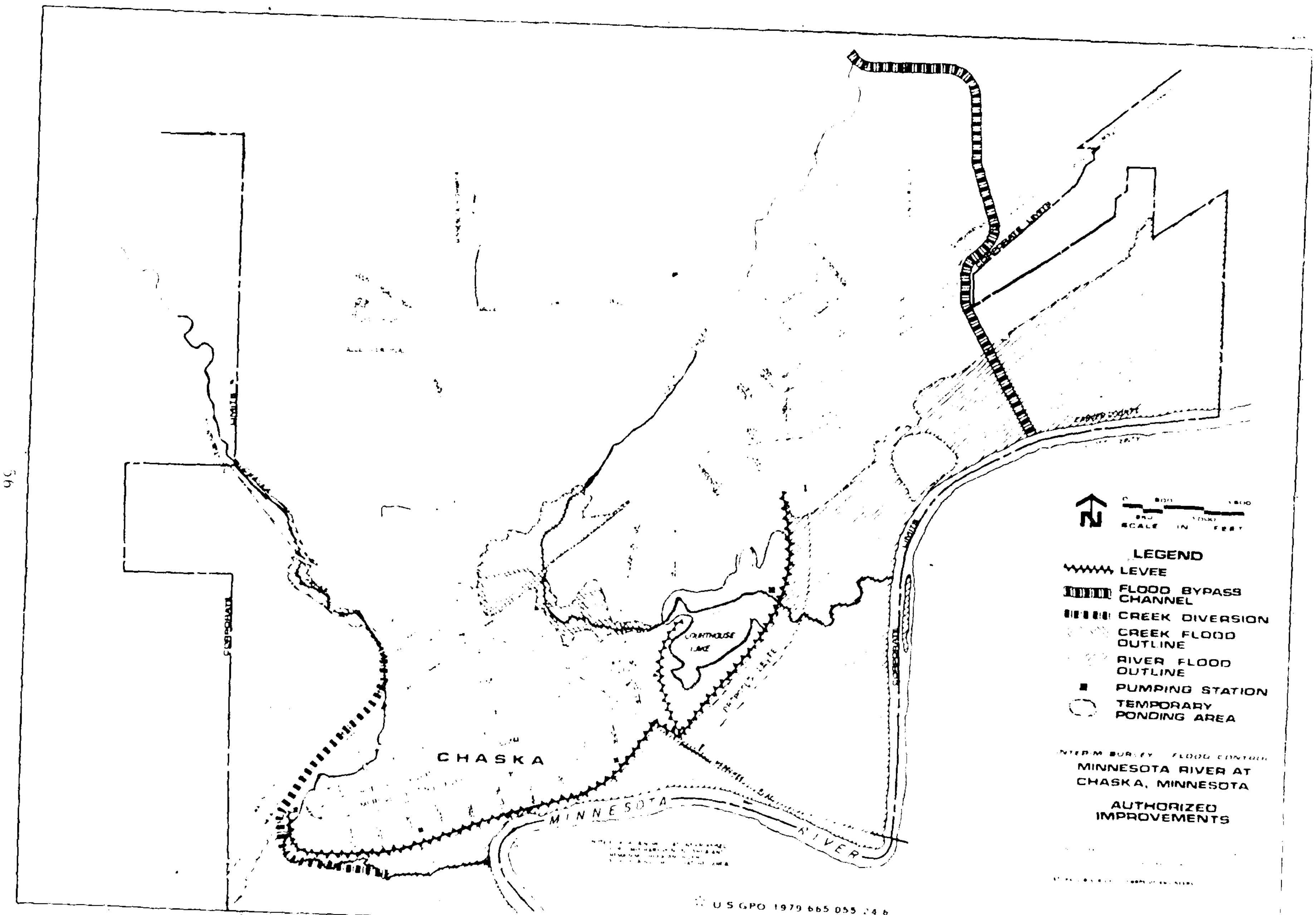


Figure 12.-- Proposed flood control plan for the city of Chaska

SOCIAL ANALYSIS

LIMITED REEVALUATION REPORT

MINNESOTA RIVER AT CHASKA, MINNESOTA

APPENDIX 9

PREPARED BY THE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

APPENDIX 9

SOCIAL ANALYSIS

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

TABLES

POPULATION

The city of Chaska maintained a population of about 2,000 persons between the late 1800's and 1950. Then the influence of contiguous metropolitan growth and west suburban job opportunities induced a 24-percent increase in Chaska's population between 1950 and 1960. The rate of growth increased rapidly during the 1960's, resulting in a 74-percent increase in Chaska's population between 1960 and 1970. Since 1970, the population in Chaska has grown at an annual rate of about 6.5 percent. Growth in Chaska during the last decade accounts for nearly 50 percent of the increase in the population of Carver County. The following table summarizes recent population trends.

Population and population change by State, county, and city

Year	Minnesota	Carver County	Chaska
1950 (1)	2,982,483	18,155	2,008
1960 (1)	3,413,864	21,358	2,501
1970 (1)	3,806,103	28,331	4,352
1975 (2)	3,916,105	33,609	6,839
Percentage change 1950-1960	14.5	17.6	24.6
Percentage change 1960-1970	11.5	32.6	74.0
Percentage change 1970-1975	2.9	18.6	57.1

(1) 1960 Census of Population, Characteristics of the Population, U.S. Bureau of the Census.

(2) County and City Data Book, 1977.

Population forecasts predict a similar rate of growth for Chaska during the next decade. It is expected that Chaska's population will increase 88 percent (from 8,300 to 15,600) by the year 1990. The following table shows historic and projected population figures for Chaska.

Historic and projected populations for Chaska[1]

Year	Population	10-year change: Number	10-year change: Percent
1950	2,000		
1960	2,500	500	25
1970	4,350	1,850	74
1980	8,300	3,950	91
1990	15,600	7,300	88
2000	22,500	6,900	44

Source: Comprehensive Plan, City of Chaska, Minnesota, December 1980.

(1) Projections take Jonathan's current growth status into consideration.

The table below presents population density figures for 1970 and 1975. Each location, with the exception of Minneapolis, reflects an increase in density. Chaska experienced the highest increase with a 23.9 percent change over the 5-year period.

Population density (persons per square mile)[1]

Location	1970	1975	Percent change
Minnesota	48.0	49.4	+ 2.9
Carver County	78.9	93.0	+18.6
Chaska	300.1	471.7	+23.9
Minneapolis	7,827.0	6,812.3	-13.0

1. County and City Data Book, 1977

The 1970 age distributions for Chaska, Carver County, and the State of Minnesota are presented in the next two tables.

Age distribution (1970)

Age	Number			Percentage		
	Minnesota[1]	Carver County[2]	Chaska[3]	Minnesota	Carver County	Chaska
< 5	332,000	2,737	450	8.72	9.67	10.34
5-14	818,300	6,780	982	21.50	23.95	22.56
15-24	665,900	4,361	714	17.50	15.40	16.41
25-34	456,600	3,431	566	12.00	12.12	13.01
35-44	395,800	3,243	471	10.40	11.46	10.82
45-54	397,200	2,716	375	10.44	9.59	8.62
55-64	332,700	2,179	313	8.74	7.70	7.19
65+	407,500	2,863	481	10.71	10.11	11.05
Total	3,806,000	28,310	4,352	-	-	-
Median age	26.8	25.7	25.5			

(1) Population Estimates and Projections, Series P-25, No. 796, U.S. Department of Commerce, Bureau of the Census.

(2) U.S. Census of Population 1970, Minnesota General Population Characteristics, U.S. Department of Commerce, Bureau of the Census. PC(1)25B.

(3) 1970 Census 4th Count M.C.D. Record Type 1 (Total) (Metropolitan Council).

Population and age distribution[1]

Age	Chaska 1970 total	Percentage of 1970 population: Chaska	Carver County	Minnesota
< 18	1,690	38.83	39.97	36.31
18-64	2,181	50.12	49.92	52.95
65+	481	11.05	10.11	10.74
		N=4,352	N=28,310	N=3,804,971

(1) PC(1) 25B U.S. Census of Population (1960 and 1970) Minnesota General Population Characteristics. U.S. Department of Commerce, Bureau of Census.

As shown below, while similar patterns of distribution are apparent, Chaska's relatively younger population is characterized by a significant increase in the proportion under 18 years of age during the preceding decade.

Relative change in percent of total population, 1960-1970[1]

Age	Change (in percent): Chaska	Carver County	Minnesota
< 18	+[illegible]	+[illegible]	-1.29
18-64	-[illegible]	-[illegible]	+0.93
65+	-[illegible]	+[illegible]	+0.36

(1) PC(1) 25B U.S. Census of Population (1960 and 1970) Minnesota General Population Characteristics. U.S. Department of Commerce, Bureau of Census.

HOUSING

COUNTY AND STATE

Between 1960 and 1970 the growth in year-round housing units for Carver County (34.8 percent) was slightly more than double that for the State (16.5 percent). The percentage of owner-occupied housing units for 1970 was slightly greater in Carver County (77.4) than in the State (71.5). Carver County and the State maintained a similar proportion of occupied units which were lacking in some or all plumbing facilities with 6.1 percent and 5.9 percent, respectively. The median value of owner-occupied single family dwelling units in 1970 was $19,328 for Carver County and $18,054 for the State. The median gross rent for Carver County was equal to that for the State at $117.

During 1975 and 1976 the number of new housing units authorized by building permits in Carver County was 428, 91.6 percent of which were single unit structures. In contrast, 46,364 new housing units were authorized by building permits in the State, 75 percent of which were single unit structures. The total construction value of structures for private residential living in Carver County during the period was $14,989,000. (County and City Data Book, 1977.)

CITY

Pattern of Development

The current pattern of urban development in Chaska is the result of three growth characteristics: (1) the old town outward expansion, (2) Jonathan New Town development, and (3) in-fill of mid-Chaska between Jonathan and old town (brought about largely by the extension of sewer and water facilities and other utilities to serve Jonathan).

Number and Type of Housing Units (1970 and 1979)

As of September 1979, Chaska had about 3,100 housing units, more than double the approximately 1,300 units in 1970. The average annual growth rate for Chaska was 175 units per year; the development of Jonathan New Town accounted for 57 percent of this increase.

As shown in the following table, single family units constituted roughly half of the city's housing in 1979, whereas they accounted for slightly more than two-thirds of the city's housing in 1970. Multiple family units have maintained a fairly stable proportion (1/4) of the city's housing over the last decade, while mobile homes accounted for 14 percent more of the city's housing than in 1970.

Chaska housing by type, 1970 and 1979[1]

Housing type	April 1970 Number	April 1970 %	September 1979 Number	September 1979 %	1970-1979 Increase Number	1970-1979 Increase %	Percent increase by type	Change in % of total
Single family	907	68.3	1,556	50.4	649	36.9	71.6	-17.9
Townhouses	-	-	157	5.1	157	8.9	-	+5.1
Multiple family	333	25.1	736	23.9	403	22.9	121.0	-1.2
Mobile homes	87	6.6	636	20.6	549	31.3	631.0	+14.0
Total	1,327	100.0	3,085	100.0	1,758	100.0		

(1) Source: Comprehensive Plan, City of Chaska, December 1980.

Housing Construction Rate, 1970 to (September) 1979

City building permit records by year and by type are summarized below. (Mobile homes are not reported by year.)

Residential building permits by type, 1970-1979

Year	Single family	Townhouse	Multiple family	Mobile homes	Total
1970	30	92	24	-	146
1971	135	26	48	-	209
1972	133	34	159	-	326
1973	26	34	46	-	106
1974	27	2	30	-	59
1975	31	-	-	-	31
1976	29	-	-	-	29
1977	68	-	-	-	68
1978	89	4	114	-	207
1979	60	-	-	-	60
Total	628	192	421	549	1,790

Source: Comprehensive Plan, City of Chaska, December 1980.

The table above reveals an average of 179 permits per year; however, a broad range is displayed from a low of 29 in 1976 to a high of 326 in 1972. The variance in annual permits reflects both Jonathan's peak development years in the early 1970's and a mid-1970's recession, especially apparent in the reduction of townhouse and multiple family unit construction since 1974.

Recent Development

The proportion of owner-occupied units in Chaska has increased from 70 percent in 1970 to approximately 77 percent in 1979.

Between 1975 and 1980 the number of new housing units authorized by building permits in Chaska was 442, of which 70.1 percent were single family structures. The total value of structures for private residential living during the period was $17,318,671. The following is a summary of new construction value in Chaska from 1975 through 1980.

New construction value, 1975-1980

Type	Number	Estimated value
Single family	310 units	$13,612,571
Apartments	132 units	3,706,100
Industrial	17 projects	4,784,215
Commercial	10 projects	915,300

Source: City Building Inspector, city of Chaska, December 1980.

Chaska's two mobile home parks have also expanded in the last 5 years. Riverview Terrace has added 60 lots, bringing its capacity to 237 units. Brandondale has added 147 lots, bringing its capacity to 499 units.

Low Income and Subsidized Housing

The Municipal Housing Profile prepared by the Metropolitan Council in June of 1974 provided the following data regarding the availability of low and moderate income housing.

	Chaska	Carver County
Percentage of total housing in price range of low and moderate income persons	40.5	29.3
Percentage of housing units subsidized	5.9	1.6

In reviewing applications for Federal assistance grants and programs, the Metropolitan Council ranked Chaska fourth in the entire metropolitan area based on the city's adherence to "Housing Policy 31." (Source: Metropolitan Council. Priority Review of Trunk Highway 212, September 1976.) As of September 1979, 252 subsidized housing units existed in Chaska, representing 8.2 percent of the total housing stock. (Source: Comprehensive Plan, city of Chaska, December 1980.)

Projected Numerical Housing Goals

Chaska has accepted the Metropolitan Council's 1990 forecast of 5,600 total households. This forecast would mean the addition of some 2,500 housing units, close to double the 1979 count of 3,085 units. The resultant 1979-1990 rate of housing increase would be nearly 230 units per year, a 31 percent higher rate of annual growth than occurred from 1970 through 1979. The following table shows the city of Chaska's numerical goals for housing types.

Housing forecast

	1979		1990		Increase
Type	Number	Percent	Number	Percent	(number)
Single family	1,566	50.4	3,019	54.0	1,463
All multiple	893	29.0	1,848	33.0	955
Mobile home	636	20.6	733	13.0	97
Total	3,085	100.0	5,600	100.0	2,515

Source: Comprehensive Plan, city of Chaska, December 1980.

Structures Within Special Flood Hazard Areas

Estimates of the number of structures of various types that are located within special flood hazard areas in Chaska are shown below (Source: Flood Insurance Study, April 1977, city of Chaska, U.S. Department of Housing and Urban Development - Federal Insurance Administration):

One to four family units	520
Multifamily units	5
Small businesses	49
All others	10

GOVERNMENT

Chaska is governed by a four-member elected city council, an elected mayor, and an appointed city administrator. Two council members are newly elected every 2 years to 4-year terms. The election for mayor is held every 2 years. The mayor chairs all council meetings, but the mayor's power is identical to that held by council members. The city council has ultimate approval authority over all aspects covered by city ordinances, including, but not limited to, zoning, land use planning, subdivision regulations, and water and sewer planning. The city council received advice and assistance in its decision making from the Chaska Planning Commission.

The revenue and expenditures for the city of Chaska for the years 1975 through 1979 are shown on the next page.

Chaska revenue and expenditures, 1975-1979

Revenue

Year	Revenue Sharing	Property Taxes	State Aid	Special Assess-ments	Licenses, Permits, Fines, Other Service Charges	Public Service Enter-prises	Other Revenue and Nonrevenue Receipts	Total
1975	$60,623	$189,709	$223,614	$ 863,637	$ 57,404	$1,594,762	$ 360,043	$3,349,792
1976	53,569	218,454	183,925	778,555	69,480	1,932,916	187,053	3,423,952
1977	48,865	289,632	223,739	1,859,614	77,138	2,213,274	2,130,000	6,842,262
1978	53,570	288,579	233,677	1,284,453	104,731	2,403,960	425,934	4,799,904
1979	53,885	328,719	231,156	1,069,104	93,799	2,167,768	109,300	4,053,731

Expenditures

Year	General Govern-ment	Public Safety	Utilities	Public Works & Parks	Bond Redemption & Special Assessments	Other	Total
1975	$224,267	$216,650	$1,454,255	$150,000	$1,208,111	$ 529,956	$3,783,239
1976	348,500	179,593	1,577,719	162,453	757,270	318,196	3,343,731
1977	339,373	162,187	1,899,171	163,838	724,794	1,976,801	5,266,165
1978	430,384	232,113	1,979,049	330,862	922,352	203,196	4,097,956
1979	342,576	285,802	2,202,707	341,407	1,106,518	195,786	4,474,796

(Source: Chaska City Administrator, November 1980).

The following table shows tax rates for Carver County and Chaska.

Tax rate in mills, 1976-1980 (1)

Unit	Collection year 1976	1977	1978	1979	1980
Carver County	32.97	31.79	32.55	30.19	38.01
Chaska (Urban)	13.44	14.19	13.73	14.73	18.54
Chaska (Rural)	5.68	5.68	5.42	5.58	6.52
Ind. School Dist. 112	70.96	73.41	69.56	65.55	55.41

Source: Chaska City Administrator, November 1980.

(1) Minnesota real estate taxes are based on market value; that value times 43 percent equals the assessed valuation. Assessed valuation times the mill rate yields the property taxes.

A $1.36 million 1981 city operating budget for the city of Chaska was approved by the City Council on 30 September 1980. An estimated expenditure comparison for the year 1980 and 1981 is shown below.

Expenditure comparison

Item	Estimated 1980	Estimated 1981
General	$1,057,600	$1,227,600
Mount Pleasant	5,600	5,600
Equipment	134,532	68,600
F.R.A.	22,500	22,500
Debt service	39,458	36,065
Total	1,259,690	1,360,365

General fund budget comparison

Item	1980	1981	Difference (percent)
General government	$206,800	$216,786	+ 4.8
Public safety	352,800	379,458	+ 7.7
Public works	402,410	433,119	+ 7.6
Recreation-parks	74,625	91,506	+22.6
Community development	56,725	[illegible]	- [illegible]
Unallocated general exp.	28,000	[illegible]	+[illegible]
Total	1,120,980	[illegible]	+ 9.[illegible]

A major decrease in the 1981 budget came in the equipment fund. The city purchased and equipped a new fire truck in 1980, which is the reason for the larger 1980 expenditure. A 22.6-percent increase in recreation and parks is largely a result of including $5,800 in liability insurance and approximately $3,000 in workers' compensation in the 1981 budget. (Source: Carver County Herald, 1 October 1980.)

COMMUNITY SERVICES

POLICE DEPARTMENT

The Chaska City Police Department has its offices in City Hall. There are nine full-time officers and no volunteers. The department operates five radio-equipped patrol cars, three marked and two unmarked. The department serves only the area within the city limits; however, it occasionally provides assistance to other jurisdictions within Carver and Scott Counties. The department responded to an estimated 5,000 calls during 1980. (Source: Chief of Police, 24 December 1980.) The 1981 budget for the Police Department was up 12.7 percent from 1980 ($254,680 to $286,983). (Source: Carver County Herald, 1 October 1980.)

FIRE DEPARTMENT

The Chaska City Fire Department is entirely volunteer and is composed of 35 individuals. The department operates out of 1 stationhouse and maintains 10 pieces of equipment which include 5 pumpers, 1 100-foot aerial rig, 1 tanker, 1 grass rig, 1 chief's car, and 1 ambulance. The area of service extends beyond the city limits into Laketown and Chaska Townships. An estimated 165 fire and 340 ambulance responses were made during 1980. (Source: Chaska Fire Chief, 13 January 1981.) The 1981 budget fo the Fire Department was up 49 percent from 1980 ($52,605 to $78,425). This figure has

been labeled as misleading by the city administrator since the 1980 fire protection budget does not indicate the $18,000 in Federal revenue sharing money used to equip the new fire truck. Taking this into consideration yields a 10-percent increase from 1980 to 1981. (Source: Carver County Herald, 1 October 1980.)

MEDICAL FACILITIES

The nearest hospital is Saint Francis in Shakopee, about 5 miles away. The licensed capacity is 126 beds; however, the hospital operates and staffs for a 107-bed capacity. Twenty-four-hour emergency service is available. During fiscal year 1980, the hospital received 9,083 emergency patients. As of July 1980, the hospital staff had 130 physicians composed of the following:

- 29 Active physicians (full admitting privileges).
- 23 Associate physicians (restricted admitting privileges).
- 57 Consulting physicians (specialists restricted to 10 admissions per year).
- 21 Courtesy physicians (restricted to three admissions per year).

The hospital owns three ambulances and maintains two in operation, both of which are advanced life support units.

Complicated treatment cases are referred to a variety of hospitals in the Twin Cities Metropolitan Area, depending on the nature of the case (Source: St. Francis Hospital Administration Staff, 14 January 1981):

- Burns - St. Paul Ramsey.
- High risk obstetrical - Abbott Northwestern.
- Severe head injury - University of Minnesota.
- Critical children cases - Children's Hospital of Minneapolis.
- Psychological - Golden Valley Health Center.
- Chemical dependency - St. Mary's.

MEETING FACILITIES

Chaska uses primarily two locations for public meetings, the capacities of which are 150 and 80 persons, respectively. Other meeting places are available, however, at least three of which have capacities of 200 persons.

LIBRARIES

Chaska has one public library with approximately 13,000 volumes. The Chaska library is part of the Carver County library system, which has about 40,000 volumes. A fire in March 1980 resulted in the loss of 300 to 400 magazines and periodicals which have since been replaced. Annual circulation is presently estimated to be about 53,000 items. (Source: Chaska Head Librarian, 12 January 1981.)

UTILITIES

Chaska buys electrical service from Northern States Power. The city is responsible for the distribution of electricity to individual customers.

Water is provided by three of four city wells. The total storage capacity of the city's three tanks is 2.15 million gallons. The capacity of the water distribution system is 1.5 million gallons per day. The average demand is 0.4 million gallons per day uring the winter and 1.5 million gallons per day during the summer. The peak demand for water reaches 2 million gallons per day. Two filter purification systems are used, one pressure-aerated and one gravity system. Fluoride is added to the water.

Gas service is provided by Minnesota Natural Gas Company.

Telephone service is provided by United Telephone Company.

Wastewater treatment is provided by Metro Sewer, which handles an average annual load of 350 million gallons. The capacity of the treatment plant is [illegible] million gallons per day, peak demand is 2.8 million gallons per day, and the average demand is 1.4 million gallons per day. (Source: Chaska Superintendent of Utilities, January 1981.)

The Hazeltine wastewater receptor is inadequate to handle the ultimate design flow and would require expansion at the time Chaska's development reaches a population of approximately 12,000 people, which is projected to occur around 1985. The remainder of the city's trunk sewer system is in place to serve existing and projected development well into the 1990's. (Source: Comprehensive Sewer Plan, 1980. Bonestroo, Rosene, Anderlik and Associates, Inc.)

EDUCATION

Independent School District No. 112 currently maintains five public schools. Two parochial schools and one private preschool also operate within the boundaries of the district. Additions were made to Chaska's Senior High in 1967 and 1970. The Chaska Middle School was constructed in 1976. Current and projected enrollment figures are shown below.

School enrollment

Schools	Grades	1980 enrollment	Capacity
Public			
Chaska Elementary	K-5	671	750
Chanhassen Elementary	K-5	542	750
East Union	K-5	169	216
Total elementary		1,382	
Chaska Middle School	6-8	709	1,250
Chaska Senior High	9-12	1,064	1,[illegible]50
Total public enrollment		3,155	
Private			
St. John's Lutheran	K-[illegible]	[illegible]	200
Guardian Angel	K-[illegible]	[illegible]	395
Montessori	Preschool	[illegible]	-
Total private		[illegible]	

Projected public enrollment
(based on December 1979 estimates)

Year	Enrollment
1981-1982	[illegible]
1982-1983	[illegible]
1983-1984	[illegible]
1984-1985	[illegible]

Private schools currently enroll approximately 15 percent of the Chaska student population, a proportion that is expected to be maintained for the next 5 years.

Mean student/teacher ratios for public schools in the district (rearranged to be based on K-6, 7-9, and 10-12 grade categories for comparative purposes) are shown below.

K-6	24.51
7-9	23.24
10-12	21.91

The student/teacher ratios for Chaska's two parochial schools are very different, Guardian Angel with [illegible] and St. John's with [illegible] student/teacher ratio. (Source: Chaska Public Schools - District Superintendent, January [illegible]. Private Schools - conversations with respective principals, January [illegible].)

Chaska has no vocational technical schools, colleges, or universities. The nearest vocational technical school is in Eden Prairie, [illegible] miles away. The nearest community college is [illegible] miles away in Bloomington. There are [illegible] colleges and universities within the bounds of the 7-county metro area.

The following table provides a comparative summary of the educational achievement of all persons [illegible] years old and above in Minnesota, Carver County, and Chaska for the years [illegible] and [illegible].

Educational attainment						
	1960			1970		
Percent finished	Minnesota	Carver County	Chaska(1)	Minnesota	Carver County	Chaska
8 or less years	40.13	54.05	-	27.66	39.44	[illegible]
Some high school	15.15	12.42	-	14.93	12.37	[illegible]
High school degree	25.01	22.31	-	34.23	28.88	[illegible]
Some college	10.39	6.41	-	12.02	9.57	[illegible]
College degree	7.48	4.47	-	11.15	9.02	[illegible]

(1) Information not available.

While Chaska demonstrates the highest proportion achieving high school degrees, the figure is due in part to Chaska's relatively lower proportion pursuing or achieving a college degree. (The percentages include only those people who <u>stop</u> at each level.) (Source: Minnesota and Carver - 1960 and 1970 U.S. Census of Population, Minnesota Social and Economic Characteristics. Chaska - 1970 Census, 4th count.)

TRANSPORTATION

Chaska is located 15 miles southwest of Minneapolis St. Paul on State Highway 41. Highway 41 runs in a north-south direction through the city of Chaska and provides the main bridge crossing of the Minnesota River for the Carver County area. The nearest interstate highway is I-494, 10 miles northeast of Chaska.

Chaska's metropolitan highway system, proposed to be completed by [illegible], includes constructing Trunk Highway (T.H.) 212 on a new alignment as a four-lane divided freeway with fuly controlled access west from I-494 to existing

T.H. [illegible] and partially controlled access west of T.H. 41. Additionally, T.H. [illegible] is planned as a high-level Minnesota River crossing on a new alignment as a four-lane divided freeway with fully controlled access. The new facility will connect existing T.H. 169 south of Shakopee with proposed T.H. 212 in Chaska.

The Metropolitan Transit Commission currently operates two round-trip express buses between Chaska and downtown Minneapolis each weekday. Ridership has consistently been high at about 175 rides per day out of a maximum capacity of about 200 daily rides. (Source: Comprehensive Plan, City of Chaska, December 1980.)

Intercity bus service is provided by Greyhound, Jefferson, Zephyr, and Dickerson. Railroad freight service is provided by Chicago and Northwestern Transportation Company. United Parcel Service is also available.

The nearest airport is Flying Cloud, about 8 miles northeast of Chaska on Highway [illegible]. It generally provides services for private aircraft; its longest runway is [illegible] feet long. The Minneapolis-St. Paul International Airport, served by five national/international, three regional, six national, and six local airlines, is about 20 miles northeast of Chaska. (Source: Minnesota Community Profile, Minnesota Department of Economic Development, March 1980.)

EMPLOYMENT

[illegible] employment by industry for Chaska, Carver County, and the State of Minnesota is shown in the table below. The greatest portion of Chaska's labor force is, respectively, committed to manufacturing, services and trade - a pattern similar to that of Carver County. In contrast, the State's greatest portion of the labor force is committed to services, trade and manufacturing, respectively.

[illegible] Employment by Industry - Chaska, Carver County, and [illegible]

Industry	Percentage of Chaska's Labor Force[1]	Percentage of Carver County's Labor Force[illegible]	Percentage of Minnesota's Labor Force[illegible]
[illegible], [illegible] Fisheries	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	3.[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible], [illegible] [illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1[illegible]	19.[illegible]	[illegible]
[illegible], [illegible], Real Estate	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	21.[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	—

[illegible] MCD Reports, Type [illegible] [illegible]

[illegible] and Economic Characteristics, Minnesota, [illegible]. [illegible] Department of Commerce, Bureau of the Census.

[illegible] of Population, Volume [illegible], [illegible] Summary and State Tables, U.S. Bureau of the Census.

The [illegible] economic base of Carver County by major industrial categories is displayed in the table below. The number of employees in the various industries is compiled along with the number of employing firms in each type of industry. The industries with the largest number of firms in Carver County were retail trade, services, contract construction and manufacturing in descending order. The industrial categories employing the largest number of workers were manufacturing, services and retail trade. The service industry was the only one in which any of the firms employed [illegible] or more individuals.

Carver County employees and establishments by industry, 1977[1]

Industry	Number of employees for week including March 12	Number of establishments, by employment-size class: Total	1 to 4	5 to 9	10 to 19	20 to 49	50 to 99	100 to 249	250 to 499
Total	5,902	599	367	106	64	40	15	6	1
Agricultural services, forestry, fisheries	49	13	8	4	1	–	–	–	–
Mining	–[2]	1	1	–	–	–	–	–	–
Contract construction		85	64	10	8	2	1	–	–
Manufacturing	2,140	63	11	14	13	13	7	5	–
Food and kindred products	366	5	–	2	–	1	1	1	–
[illegible]r and misc. plastics products	151	3	–	–	1	–	2	–	–
[illegible] metal products	225	9	1	2	2	3	1	–	–
[illegible] structural metal products	119	4	1	1	1	–	1	–	–
[illegible], except electrical	175	14	5	1	5	3	–	–	–
[illegible] and other public utilities	283	28	19	4	1	2	2	–	–
[illegible] and warehousing	93	17	14	2	–	–	1	–	–
[illegible] trade	274	52	35	9	6	2	–	–	–
Retail trade	1,176	164	103	36	17	12	1	–	–
[illegible]									
[illegible]	74	20	16	3	1	–	–	–	–
[illegible]	212	23	15	2	2	4	–	–	–
[illegible]									
[illegible]	282	37	18	11	4	4	–	–	–
[illegible]	280	43	23	[illegible]	[illegible]	4	–	–	–
[illegible]	143	30	21	7	1	–	1	–	–
[illegible] real estate	348	49	44	[illegible]	[illegible]	2	–	1	–
[illegible]	122	10	1	3	4	2	–	–	–
[illegible]	1,224	131	84	22	13	7	[illegible]	–	1
[illegible]	417	30	17	5	3	1	[illegible]	–	–

[illegible] Business Patterns, Minnesota 1977, U.S. Department of [illegible] Census.

[1] [illegible] employees, railroad employees, self-employed persons, [illegible] "General Explanation" for definitions and statement on [illegible] size class 1 to 4 includes establishments having [illegible] employees during mid-March pay period.

[2] Number of employees [illegible] exact numbers were not made available.

RETAIL TRADE

There were 272 retail trade establishments in Carver County in 1972. The distribution of sales by various types of businesses for Carver County and the State of Minnesota is shown below. While the rate of sales in eating and drinking establishments was roughly 78 percent higher in Carver County than in the State of Minnesota, the rate of sales in general merchandise was more than seven times higher in the State than in Carver County. The remaining sectors of retail trade display relatively equal rates of sales for Carver County and the State.

Retail trade - Carver County and Minnesota, 1972

Type	Carver County Number	Carver County Percent of sales	Minnesota (percent of sales only)
Food stores	34	18.7	19
Automobile dealers	14	21.7	18
General merchandise group stores	5	2.0	14.9
Eating and drinking places	64	14.1	7.9
Gasoline service stations	36	11.6	8.5
Furniture, home furnishings and equipment	14	3.4	4.5
Other[1]	105	-	-
Total	272		

Source: County and City Data Book, 1977.

(1) Only the major categories have been listed separately.

Major employers in the Chaska area are shown in the following table. The majority of employment in Chaska for 1980 was provided by food industries.

Major employers in the Chaska area

Firm	Product/service	No. employees	Union	Percentage of employees in union
Green Giant Company	Corporate office	265	None	
M. A. Gedney Company	Pickle processing	125	Team.	100
Minnetonka, Inc.	Cosmetics & soap mfg.	150	None	
Preferred Products, Inc.	Packaging company	105	Team.	78
HEI, Inc.	Film circuits assembly	94	None	
Flame Industries, Inc.	Friction welding	90	Team.	100
Fluoroware, Inc.	Integrated circuits	67	None	
Fluoroware Systems, Inc.	Micro-electric mfg.	55	None	
Peavy Company	Prod. research/testing	45	None	
Quali-Tech, Inc.	Animal nutrients mfg.	42	None	

Source: Chaska, Minnesota, Community Profile, Minnesota Department of Economic Development, 1980.

About 83.6 percent of Chaska's males 16 years old and over were engaged in the 1970 labor force compared with Carver County's 82.0 percent and the State's 77.1 percent. An estimated 45.5 percent of Chaska's females 16 years old and over were engaged in the 1970 labor force compared to 44.7 percent in Carver County and 43.5 percent in the State. Unemployment in Chaska's 1970 civilian labor force amounted to 3.5 percent for males and 2.6 percent for females (16 years old and over). (Source: General Social and Economic Characteristics, Minnesota, 1970, P(1)-C25, Department of Commerce, Bureau of the Census.)

Unemployment in Chaska in 1980 was calculated to be 3.3 percent of the entire civilian labor force. (Source: Chaska, Minnesota, Community Profile, Minnesota Department of Economic Development, 1980.)

Income characteristics for families in Chaska, Carver County, and the State of Minnesota are compared in the following table.

Median and mean family income in Chaska was greater than that for either Carver County or the State. Chaska had the highest percentage of families which had incomes in excess of $15,000 in 1970, almost twice that found in the State. However, the percentage of families having an income below the official poverty level in 1970 was 2.77 times higher in Chaska than in the State.

Family income for Chaska, Carver County, and Minnesota, 1970

Range	Chaska	Carver County	Minnesota
Percent of families:			
Under $3,000	3.25	8.96	8.99
$3,000 to $5,999	4.95	11.80	14.89
$6,000 to $8,999	13.07	19.41	19.43
$9,000 to $11,999	20.92	20.72	21.44
$12,000 to $14,999	16.14	16.48	14.97
$15,000 to $24,999	31.26	17.42	15.96
$25,000 to $49,000	8.63	4.44	3.64
$50,000 and above	1.79	0.77	0.70
Median family income	$14,452	$10,427	$9,931
Mean family income	$14,951	$11,543	$11,098
Percent with income less than poverty level	9.3	11.2	8.2

Estimated per capita incomes for Chaska, Carver County, and Minnesota for the years 1969 and 1977 are shown in the table below. Both the absolute per capita income and the increase from 1969 to 1977 were higher for Chaska than either Carver County or the State.

Item	Estimated per capita income 1969	1977	Percent change
Chaska	$3,090	$5,969	93.2
Carver County	3,009	5,735	90.6
Minnesota	3,038	5,778	90.2

Source: Population Estimates and Projections, Series P-25, No. 884, issued June 1980, U.S. Department of Commerce, Bureau of the Census.

COMMUNITY RESPONSIVENESS

Approximately 19,500 persons in Carver County were citizens of voting age in 1972. Of these eligible voters, 71.3 percent voted in the 1972 general election. This turnout was somewhat higher than the 68.9 percent figure for the State of Minnesota. (Source: County and City Data Book, 1977.)

Four public meetings were held in Chaska during fall of 1979 to discuss the city's flood control project. Over the course of the meetings, 91 citizens participated and voluntarily completed questionnaires. Participants represented a variety of residential and employment sectors. The most noticeable degree of under-representation was in those residential areas constituted primarily by trailer courts. Participants represented a variety of community groups, the greatest proportion from civic and political groups and volunteer firemen. The specific delineation of residential, employment and group representation is shown in the following two tables.

Participation at 1979 public meetings on Chaska flood control project [1]

Number of individuals	Group represented (Categories available on questionnaire)
10	Civic (e.g., Rotary, Kiwanis)
1	Environmental (e.g., Audubon, Izaak Walton League)
6	Recreational (e.g., National Rifle Association, sports clubs)
11	Political (e.g., League of Women Voters, DFL, GOP)
5	Social (e.g., Elks, Eagles, Scouts, others specified by respondent)
2	Park board
4	Planning commission
2	Public works
3	Chaska flood control
3	City
1	Masons
1	Church
10	Firemen
1	4-H

(1) Total figures for four meetings.

Representation by area of residence and employment

Area No. and description	Number of participants who were residents of this area	Number of participants who worked in this area
1. Residential area around Chaska Creek	37	2
2. Residential area of Central Chaska	6	17
3. Residential area around East Creek	11	1
4. Chaska Creek suburban residential area	5	1
5. Lions Park residential area	6	3
6. Trailer park and residential area	2	0
7. Jonathon	2	1
8. Trailer park and suburban area around East Creek	2	1
9. Rural Chaska	1	0
10. Industrial park	0	0

ECONOMIC ANALYSIS DAMAGES & BENEFITS

APPENDIX 10

LIMITED REEVALUATION REPORT

MINNESOTA RIVER AT CHASKA, MINNESOTA

PREPARED BY THE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

APPENDIX 10

ECONOMIC ANALYSIS - DAMAGES AND BENEFITS

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

TABLES

TABLES (cont.)

PLATES

INTRODUCTION

Flooding in Chaska, Minnesota, results in three types of economic damages: physical damages, income losses, and emergency costs. Physical damages include damages to floodplain structures and their contents, roads, sewers, and other utilities. Income losses include loss of wages or net profits over and above physical losses, to the extent that such losses are not compensated by transfer of economic activity to other establishments or postponement of the activity. Emergency costs include costs of evacuation and reoccupation, flood fighting, and disaster relief.

Damages in each of these three categories are associated with the land use of the area. Past development has occurred in portions of the city subject to flooding. Such development has taken place because people have deemed the advantages of the floodplain to be greater than the disadvantage of flood vulnerability and because knowledge of the flood hazard has been incomplete.

Flood reduction measures would release those economic resources -- land, labor, and capital -- used to fight floods and to repair or replace flood-damaged properties. Hence damage reduction would benefit national economic development (NED).

This appendix will estimate flood damages incurred in Chaska and the NED benefits of measures proposed to reduce those damages. This benefit analysis was done in accordance with the U.S. Water Resource Council's Procedures for Evaluation of National Economic Development (NED) Benefits and Costs in Water Resources Planning (18 CFR, Part 713). The project life for flood damage reduction plans is 100 years. The analysis uses the current Federal discount rate of 7 5/8 percent and October 1981 price levels.

DELINEATION OF AFFECTED AREA

The area within the 1-percent-chance floodplain encompasses approximately 390 acres behind the levee and along East and Chaska Creeks. It is virtually fully developed for residential, commercial, and public use. Public facilities in the floodplain include the Carver County Courthouse, which contains files of tax, court, and birth and death records. The Chaska wastewater treatment plant, which has a rated capacity of 1.4 million gallons per day, is also in the floodplain. The presence of the courthouse and the wastewater treatment plant in the floodplain means that the effects of flooding may potentially extend to all of Chaska, and indeed all of Carver County.

The 1980 population of Carver County was 37,046, and the total population of Chaska was 8,346. The 1-percent-chance floodplain population is estimated at 1,500, based on the number of housing units located in that part of the city. Population data are summarized in the following table.

Population data for Chaska, Carver County, and the Twin Cities, 1970-1980

Area	Population 1970	Population 1980	Percentage change
Chaska floodplain areas(1)	1,800	1,500	-16.7
Chaska	4,352	8,346	91.8
Carver County	28,331	37,046	30.8
Twin Cities Metropolitan Area(2)	1,874,452	1,985,705	5.9

(1) Corps of Engineers estimate of floodplain population.

(2) Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington Counties. (Source: Bureau of the Census.)

The data indicate that the population of Chaska has grown at an annual compounded rate of about 6½ percent since 1970. Growth in Chaska accounts for nearly one-half of the 1970-1980 increase in the population of Carver County. The decrease in the estimated floodplain population is due to decreases in the average number of persons per unit of housing. This decrease is a metropolitan area-wide phenomenon: the ratio of persons to housing units in the seven-county area declined from 3.2 in 1970 to [illegible] in 1980, according to the Twin Cities Metropolitan Council.

Further information on population, employment, and housing is contained in Appendix 9, Social and Institutional Analysis.

FLOODPLAIN CHARACTERISTICS

Chaska is subject to flooding from three sources: the Minnesota River, Chaska Creek, and East Creek. This section will describe the characteristics of each floodplain. A map of the floodplain areas is included as plate 2 of the main report.

MINNESOTA RIVER FLOODPLAIN

The Minnesota River floodplain encompasses 100 acres behind the existing city levee and is fully developed. It includes 353 homes, 21 commercial establishments, and 2 public buildings. The total value of floodplain structures is estimated at $24.2 million.

Development in the floodplain dates back to 1854 and was influenced by the ready availability of transportation. Chaska's early growth was linked with its role as a steamboat landing. Railroad construction diminished this role but encouraged further growth in flood-prone areas because the railroads were built in the floodplains and terraces of the Minnesota River

valley. The Chicago, Milwaukee, St. Paul, and Pacific (Milwaukee Road) and the Chicago and North Western railroads both passed through the older part of the town. U.S. Highway 212, the main highway connecting Chaska with Minneapolis, was built some years later along a route parallel to the railroads.

Homes in the floodplain are old, with a median age of 75 years. Development in the floodplain in the past 20 years has consisted only of fill-in on a few remaining vacant lots. The homes are of wood-frame or brick construction and are built on 1/4-acre lots. Although many of these structures were flooded to great depths in 1965, the structures are in good condition. Additions are common, and many have been rehabilitated within the last decade. According to assessor's data, the average structure value was $45,500 in 1980.

Commercial development consists of small shops and offices located on Chestnut Street (Minnesota Highway 41) or dispersed throughout the floodplain area. Public facilities are the wastewater treatment plant and the county courthouse, which was built in 1963.

A levee was built by the city after the 1952 flood and was intended to protect against a 5-percent frequency flood. The levee was overtopped in 1965, restored by the Corps, and subsequently raised about 4 feet by the city. It was raised another 2 feet prior to the 1969 flood, when it held. The levee is not constructed to Corps design standards and is considered an inadequate flood control measure, but its presence has no doubt enhanced residents' perceptions of the desirability of the floodplain.

A map showing the pattern of development in the floodplain was published with the 1973 Feasibility Report as plate C-1. The pattern has not changed significantly since.

AD-A184 474 MINNESOTA RIVER AT CHASKA MINNESOTA TECHNICAL APENDIXES LIMITED REEVALUA..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT AUG 82 8/9

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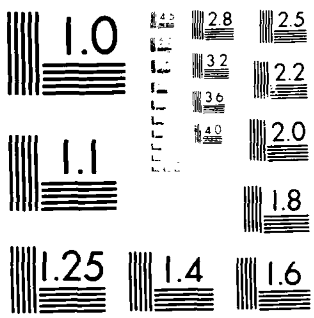


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

The 1965 flood caused extensive damage to this area. During that flood 181 homes were evacuated for an average of 33 days; 17 homes were flooded to the second floor or attic level; 136 had first-floor flooding; and an additional 80 had basement flooding. Total damages at the time were $1.7 million. The same event would cause an estimated $8.3 million in damages today. Other major floods occurred in 1969, 1968, 1957, 1952, and 1951. Further information on these floods is presented in the main report and in appendix 4.

CHASKA CREEK FLOODPLAIN

The Chaska Creek floodplain can be divided by Highway 212 into two subareas. The downstream portion which can be flooded by the Minnesota River as well as the creek is the principal damage area. It includes 194 homes and 6 businesses with an estimated total structure value of $10.1 million. The upstream portion includes 10 homes. Structures in the upstream portion have an estimated total value of $522,000.

The downstream portion of the Chaska Creek floodplain is subject to relatively high damage because it passes through a densely developed area and because its floodwaters can spill over an interior drainage divide and pond behind the city levee. Ponding depths can reach 10 feet for the 1-percent frequency event.

Characteristics of the homes and businesses in this area were discussed in the paragraphs on the Minnesota River floodplain.

Flooding was reported in July 1951, but no information is available on any resulting damages. No ponding occurred because the city levee was not in place at the time.

EAST CREEK FLOODPLAIN

The East Creek floodplain consists of two subareas: the portion downstream of Highway 212, which is also subject to Minnesota River flooding, and the portion upstream from Highway 212 along the valley terrace. The downstream portion includes 18 homes with a total structure value of $0.8 million. Upstream are 160 dwelling units (89 housing structures) in the terrace area bounded by the creek, Crosstown Boulevard, Highway 212, and County Road 17; 15 businesses (strip development) north of Highway 212 and west of Crosstown Boulevard; and a city fire station. Structure value for the upstream area is estimated at $11.2 million.

The homes in the terrace area are one-story "ramblers" built 20-25 years ago. The site has the advantage of ready access to Highway 212 (and, hence, to Minneapolis and suburbs) and proximity to the older part of the city. Knowledge of the flood hazard was probably not widespread when the homes were first sold. Assessor's sales records indicated that the average structure value of the single-family homes was $53,000 in 1980.

Commercial development includes small stores and offices; restaurants; and boat, farm implement, and automobile dealers. These firms are dependent on automobile traffic along Highway 212. Their facilities were constructed before knowledge of the flood hazard was common.

The last major flood on the creek occurred in July 1951, prior to construction of the residences and commercial buildings. Potential flood depths are about 2-4 feet above ground level for the 1-percent frequency event.

SUMMARY

Total floodplain development includes 452 residential structures (503 dwelling units), 36 commercial establishments, and 3 public buildings. The total structure value is $35.9 million. Data on floodplain development are summarized in the following table.

Summary data on Chaska floodplain, existing conditions

Floodplain[1]	Number of structures Residential	Commercial	Public	Total structure value (millions)	Maximum flood depths 1-percent frequency event (feet)
Minnesota River[2]	353	21	2	24.2	14
Chaska Creek	204	6	0	10.6	--
Within Minnesota River floodplain	(194)	(6)	(0)	(10.1)	10
Outside of Minnesota River floodplain	(10)	(0)	(0)	(0.5)	3
East Creek	107	15	1	12.0	--
Within Minnesota River floodplain	(18)	(0)	(0)	(0.8)	2
Outside of Minnesota River floodplain	(89)	(15)	(1)	(11.2)	4
Total[3]	452[4]	36	3	35.9	--

(1) These floodplains are not reaches; these are delineated by geographic area, whereas reaches are delineated by flood flow. The reach delineation can be found on page 10-14.
(2) Behind existing levee.
(3) Without double-counting of acres and structures in more than one floodplain.
(4) 503 dwelling units are contained in these structures.

PROJECTION OF ACTIVITIES IN THE AFFECTED AREA

FLOODPLAIN AREAS

Floodplain areas have changed little in the last decade, and little change is expected in the future. Population density may level off, additional homes may be refurbished, and businesses may come or go, but the overall expectation is that development in the floodplain will look much the same 25 years from now as it does today.

However, real per capita income is expected to change within the study area. OBERS Series E projections, published by the Water Resources Council in 1972 and shown in the table below, project per capita income in the Minneapolis-St. Paul area to increase from $4,117 in 1970 to $14,400 in 2020 (1967 dollars). This implies an annual rate of growth of 2.5 percent, compounded. With increased income, the value of furnisnings and personal belongings in each flood-prone house would be expected to increase, and total damage for a given flood event would rise. The increase in damages from economic changes will be evaluated in a later section.

OBERS Series E projections of real per capita income, Minneapolis-St. Paul SMSA(1), 1970-2020

Item	1970	1980	1990	2000	2020
Per capita income(2)	$4,117	$5,600	$7,100	$9,200	$14,400
Factor change	1.000	1.360	1.725	2.235	3.498

(1) Standard Metropolitan Statistical Area.

(2) Constant 1967 dollars.

Source: Water Resources Council.

UPLAND AREAS

Though changes in the floodplain are projected to be minor and of no relevance to flood damage, development in the upland portions of the creek watersheds is of great significance to downstream flood potential. Therefore, detailed projections of population, employment, and land use have been developed for these areas.

Much of the East Creek watershed is within the boundaries of Jonathan, a new-town project proposed by local investors and the Federal Department of Housing and Urban Development (HUD) in 1970. The project called for the construction of 15,286 dwelling units over a 20-year period to house about 46,000 people in a self-contained community. Projections noted in the 1973 feasibility report were for a total Chaska population of 80,000 by the year 2,000.

HUD issued grants of $4.5 million for planning, water and sewer system extensions, and purchase of open space and guaranteed $21 million in debentures issued by the investors. But the development company failed in the mid-1970's. HUD began foreclosure proceedings in August 1978, acquired the property, and sold it in 1980. Current development consists of about 900 residential units, approximately 166,000 square feet of commercial space, and nearly 1 million square feet of industrial space (see plate 10-1).

While growth in the area will not meet the goals set in 1970, a lesser degree of development will occur in the East Creek watershed. This development has implications for future runoff conditions and flood frequencies for the downstream floodplain. In October 1977 the Twin Cities Metropolitan Council developed projections of population, employment, and housing units for Chaska and all other municipalities in the seven-county region and mandated use of the projections for the development of community

comprehensive plans. The Metropolitan Council projections are in line with OBERS Series E projections developed for the Water Resources Council. Chaska is now expected to have a population of 22,500 by the year 2000. A summary of the projections with straight-line extrapolations to the year 2030 is shown in the following table.

Projections of population, employment, and housing units
within Chaska city limits

Item	1970 (Actual)	1980 (Actual)	2000	2030 ("Ultimate development")
Population	[illegible]	5,346	22,500	40,500
Employment	[illegible]	4,000(1)	6,500	15,500
Housing units	[illegible]	3,094	8,000	14,700

(1) Estimated.
Sources: Metropolitan Council for data through 2000. Corps of Engineers for extrapolation to 2030.

The city's draft comprehensive plan, dated December 1980, notes the capability of the East Creek watershed to house a population of [illegible]. Since sewer and water lines have already been extended through this area, practically all new development through 2030 will be in the East Creek watershed. Projected housing units and school, office, industrial park, and shopping areas were allocated among the nine East Creek subwatersheds on the basis of field inspection, discussions with the city planner, and consultation of the three-volume Jonathan New Community Draft Environmental Impact Statement published by HUD in December 1977. The latter describes in detail six alternative development paths for the area. A map of the nine East Creek subwatersheds appears in appendix 4. Among the assumptions for the allocation are the following:

- Approximately 10,000 housing units will be constructed in East Creek subareas E1-E9 by the year 2030. These will include 5,000 single-family homes, 625 townhouses with 4 dwelling units each, and 250 apartment buildings with 10 dwelling units each. The overall average land use density will be 4.7 dwelling units per developed acre, and each dwelling unit will have 3 people.

- In the school/office park/industrial park/shopping area category of land use, 30 percent of the total acreage is expected to be school or office park, with approximately 14,000 square feet of interior space per developed acre, and 65 percent is expected to be industrial park, with approximately 7,500 square feet of interior space per developed acre. Finally, 5 percent is expected to be commercial development (shopping area), with approximately 3,200 square feet of interior space per developed acre. Jobs created by development are expected at a rate of 51 per acre of school or office park and 9 per acre of industrial park or shopping area. Parking space would be required accordingly.

- The major highway improvement for the watershed will be the construction of a new Trunk Highway 212. Current plans are for this highway to be a four-lane, divided, "rural design" freeway with fully controlled access west from Interstate 494 to Trunk Highway 41 and partially controlled access west of Trunk Highway 41. The improvements are considered necessary by the Metropolitan Council to complete the metropolitan highway system.

The resulting allocation is summarized in the following table and mapped on plate 10-2. These data were used for hydrologic analysis of existing and future conditions on the creek.

Present and future land use, East Creek watershed, Chaska

Subbasin number[1]	Total area (acres)	Lake area (acres)	Present conditions: Residential (acres)	Present conditions: School, office, industrial park, and shopping (acres)	Present conditions: Agriculture, golf, park, and open space (acres)	Future conditions: Residential (acres)	Future conditions: School, office, industrial park, and shopping (acres)	Future conditions: Agriculture, golf, park, and open space (acres)
E1	836 (1.31 mi^2)	0	80	17	739	298	31	507
E2	336 (0.52 mi^2)	0	113	0	223	225	0	111
E3	1,072 (1.68 mi^2)	0	143	0	929	497	66	509
E4	762 (1.19 mi^2)	156	24	0	582	163	0	443
E5	1,324 (2.06 mi^2)	0	6	0	1,318	420	9	895
E6	434 (0.68 mi^2)	32	18	7	377	215	40	147
E7	500 (0.78 mi^2)	0	0	73	427	0	273	227
E8	538 (0.84 mi^2)	154	14	56	314	64	165	155
E9	572 (0.89 mi^2)	21	0	0	551	258	19	274
TOTAL	6,374 (9.95 mi^2)	363	398	153	5,460	2,140	603	3,268

(1) A map delineating the subareas appears in appendix 4.

FLOOD DAMAGES WITHOUT THE PROJECT

PRESENT CONDITIONS

Flood damages have been evaluated for present conditions using records from the 1965 flood, a floodplain structure inventory, 2-foot contour topographic maps, depth-damage curves, interviews with businessmen and public officials, and data from the flood emergency preparedness plan prepared by the city. Inventories of capital improvements in the floodplain include lists of value, ground elevation, first floor elevation, and location relative to the river or creek channel. These data allowed derivation of stage-damage and discharge-damage curves for each of three damage categories in each of five damage reaches. Average annual losses are estimated using standard damage-frequency integration techniques and the Expected Annual Damage (EAD) computer program developed at the Hydrologic Engineering Center. A complete description of the general principles of calculating average annual damages is presented in the users' manual for the program.

Damages are classified as residential, commercial, or public. Residential losses include physical damages to dwellings and their contents and to other personal property. Losses to commercial establishments include physical damages to buildings, equipment, and inventories. Public losses include physical damage to public buildings, streets, sewers, and sewer treatment facilities and the costs for labor, material, and public relief during flood emergencies.

Damage Reaches

Five damage reaches have been established for the floodplain areas. The five reaches are the areas affected by: (1) Minnesota River flooding, (2) direct flooding from Chaska Creek, (3) ponding behind the existing levee from Chaska Creek overflow, (4) East Creek flooding upstream of Highway 212, and (5) East Creek flooding downstream of Highway 212. Basic information on each reach is presented below.

Flood damage reaches at Chaska

Reach number	Reach description	Zero damage elevation or discharge	Zero damage exceedence frequency (percent)
1	Minnesota River flooding	W.S. 709.0 Minnesota River	27
2	Chaska Creek direct flooding	1,500 cfs, Chaska Creek	30
3	Ponding from Chaska Creek overflow	1,500 cfs, Chaska Creek	30
4	East Creek, upstream of 212	900 cfs, East Creek	64
5	East Creek, downstream of 212	1,850 cfs, East Creek	14

Damage analysis gives no credit to the existing city levee in protecting against flooding from the Minnesota River. The levee is not constructed to Corps standards. Technical specialists have determined that side slope, top width, seepage relief, interior drainage, tieback, and general stability of the levee are all inadequate.

Residential Damages

Residential damages have been computed for each reach with a computer program that uses information from HEC-2 output (water surface profiles) and data on house value, elevation, and location to find the depth of flooding at each structure and compute damages, which are a function of depth and structure value. Calculations were performed for each of six potential flood events, and the results served as plot points for elevation- or discharge-damage curves.

Residences can be flooded directly when water flows above ground and into the home or indirectly when water seeps into the basement or enters through a sewer drainpipe. The evaluation of residential damage includes indirect damage for reach 1, Minnesota River flooding. Seepage and backup are problems for this reach because of soil type, storm sewer configuration, and the long duration of Minnesota River flooding. However, flooding from the creeks is of short duration, and seepage and backup would not occur. Therefore, damage analyses for these reaches include direct damage only.

Residential damages for present conditions are shown below for the 10-percent, 1-percent, and 0.2-percent frequency floods. Also listed are average annual damages by reach and per unit in each reach. Total average annual residential damages are $1,335,000. Unit average annual damages for reaches 2 and 4 are high because of a greater frequency of flooding. However, damages for reaches 1 and 3 are much greater for severe flood events because of substantially greater flood depths.

Residential damages at Chaska
(October 1981 prices and conditions)

	Flood event			Average annual	(Average annual damage per	Residential structures in the
Reach	10-percent	1-percent	0.2-percent	damage	unit)	floodplain
1	$1,327,000	$ 6,352,000	$11,003,000	$ 418,000	($1,190)	352
2	1,588,000	2,064,000	2,393,000	328,000	(3,480)	94
3	140,000	2,686,000	3,876,000	88,000	(880)	100
4	1,062,000	1,372,000	1,568,000	494,000	(5,820)	85
5	21,000	126,000	209,000	7,000	(410)	18
Total	4,138,000	12,600,000	19,049,000	1,335,000	(2,050)(1)	452(1)

(1) Without double-counting structures in more than one floodplain.

Commercial Damages

Commercial damages at Chaska have been evaluated through direct interviews of business owners and managers. The estimates of damages were obtained by calculating the depth of flooding for each of three floods and estimating the damage associated with each depth. The data were then combined for each damage reach. Present conditions damages for the 10-, 1-, and 0.2-percent frequency events and average annual damages are tabulated below. Average annual commercial damages total $101,000.

Commercial damages at Chaska
(October 1981 prices and conditions)

Reach	Flood event 10-percent	1-percent	0.2-percent	Average annual damages
1	$ 20,000	$ 522,000	$1,832,000	$ 24,000
2	0	0	0	0
3	0	177,000	323,000	4,000
4	341,000	545,000	609,000	73,000
5	0	0	0	0
Total	361,000	1,244,000	2,764,000	101,000

Public Damages

Public damages were assessed from actual experience in the 1965 and 1969 floods, discussions and interviews with public officials, and consultation of the city's flood preparedness plan. The latter was written in 1980 as an appendix to the Chaska Comprehensive Stormwater Management Plan and outlines the emergency measures necessary to prepare for flooding from the Minnesota River. About one-half of public damage is for flood emergency costs. The other half is physical damage to public structures and facilities. Below is a list of data on public damages. Average annual public damages for present conditions total $226,000.

Public damages at Chaska
(October 1981 prices and conditions)

Reach	Flood event: 10-percent	1-percent	0.2-percent	Average annual damages
1	$210,000	$3,459,000	$7,189,000	$127,000
2	16,000	37,000	47,000	4,000
3	17,000	167,000	311,000	6,000
4	379,000	597,000	671,000	89,000
5	0	5,000	10,000	0
Total	622,000	4,264,000	8,228,000	226,000

Summary

Present conditions average annual damages total $1,662,000 at Chaska. The following tables present summaries of damage data by reach and damage category.

Summary of damages at Chaska by reach

Reach	Flood event: 10-percent	1-percent	0.2-percent	Average annual damage	Percentage of total average annual damage
1	$1,557,000	$10,333,000	$20,024,000	$ 569,000	34.3
2	1,604,000	2,101,000	2,440,000	332,000	19.9
3	157,000	3,030,000	4,510,000	98,000	5.9
4	1,782,000	2,514,000	2,848,000	656,000	39.5
5	21,000	131,000	219,000	7,000	0.4
Total	5,121,000	18,109,000	30,041,000	1,662,000	100.0

Summary of Damages at Chaska by category

Category	Flood event			Average annual damage	Percentage of total average annual damage
	10-percent	1-percent	0.2-percent		
Residential	$4,138,000	$12,600,000	$19,049,000	$1,335,000	80.3
Commercial	361,000	1,244,000	2,764,000	101,000	6.1
Public	622,000	4,265,000	8,228,000	226,000	13.6
Total	5,121,000	18,109,000	30,041,000	1,662,000	100.0

Composite elevation- and discharge-damage curves for each reach are presented as plates 10-3 through 10-7.

FUTURE CONDITIONS

Economic Changes

Flood damages to residential contents are projected to increase at the same rate of change as real per capita income, up to the point where content value is 75 percent of structure value. Currently, content value is estimated at 29 percent of structure value. (Study for the 1973 Feasibility Report indicated content value at 25 percent of structure value, and data in the April 1980 Survey of Current Business indicated the actual Minneapolis-St. Paul annual growth rate in real per-capita income for 1973-78 was 2.3 percent ($0.25 \times 1.023^7 = 0.29$).) Therefore, content value will increase by a factor of 2.586 (0.75 divided by 0.29). Since real per-capita income is projected to grow at a 2.5-percent compounded annual rate, content value will be 75 percent of structure value in 38 years (1.025^{38} 2.586). The net factor increase for year 38 in residential damage is 1.460 ($[0.29 \times 2.586] + [0.71 \times 1.000]$). Therefore, input for the EAD program was coded to show a factor increase of 1.460 in residential damages for year 2018, which is 38 years from 1980.

No future growth is projected for commercial or public damage. The floodplains are fully developed, and no empirical evidence is available to project increases in contents and inventories of commercial and public structures.

Hydrologic and Hydraulic Changes

Hydrologic and hydraulic conditions are projected to change over the next 50 years with upstream development in the creek watersheds and slow aggradation of the Minnesota River channel. These changes are analyzed in Appendix 4, Hydrologic Investigations. Discharge-frequency and stage-frequency curves for future conditions, year 2030, have been entered as input for the EAD model in order to compute increases in damages from hydrologic and hydraulic changes.

Equivalent Annual Damages

Equivalent annual damages are computed by the EAD program by calculating the damages for each year in the period of analysis, discounting these values to the base year, and amortizing the present value over the period of analysis. The following table presents damages for each reach and category by decade and also lists equivalent annual damages. Equivalent annual damages are $2,424,000 without flood damage reduction measures.

Equivalent annual damages without project at Chaska
(October 1981 prices, 7 5/8-percent discount rate)

Damage categories	Study year 1980	Base year 1986	Decade years 10 1995	20 2005	30 2015	40 2025	50 2035	End of period 2085	Equivalent annual damage
Reach 1 = Minnesota River flooding									
Residential	418	454	529	572	638	667	673	673	526
Commercial	24	25	25	26	27	28	28	28	26
Public	127	130	133	136	140	144	145	145	134
Total	569	609	667	734	805	839	846	846	686
Reach 2 = Chaska Creek direct flooding									
Residential	328	414	573	785	1,020	1,223	1,310	1,310	662
Commercial	0	0	0	0	0	0	0	0	0
Public	4	5	6	7	9	11	12	12	6
Total	331	419	579	791	1,029	1,234	1,322	1,322	668
Reach 3 = Ponding behind existing levee from Chaska Creek overbank flows									
Residential	88	105	141	193	264	382	468	468	175
Commercial	4	5	6	8	10	13	16	16	7
Public	6	7	9	11	13	20	24	24	10
Total	98	117	157	212	287	415	508	508	192
Reach 4 = East Creek flooding, upstream of Highway 212									
Residential	494	550	636	737	843	907	929	929	667
Commercial	73	78	86	95	105	115	121	121	90
Public	89	95	104	114	125	136	144	144	108
Total	656	723	826	1,073	1,073	1,158	1,194	1,194	865
Reach 5 = East Creek flooding, downstream of Highway 212									
Residential	7	8	11	13	16	19	20	20	12
Commercial	0	0	0	0	0	0	0	0	0
Public	1	1	1	1	1	1	1	1	1
Total	8	9	12	14	17	20	21	21	13
Total, all reaches									
Residential	1,335	1,532	1,870	2,299	2,781	3,198	3,400	3,400	2,042
Commercial	101	108	118	129	142	156	165	165	123
Public	226	237	251	269	288	312	326	326	259
Total	1,662	1,877	2,239	2,697	3,211	3,666	3,891	3,891	2,424

FLOOD DAMAGES WITH THE PROJECT

Flood damages with the proposed project are calculated by modifying input to the EAD program for the effects of flood control measures. Modifications included the following:

- Truncation of elevation- and discharge-damage curves for reaches 1-3 at the design level of protection.

- Derivation of new frequency-damage analyses for reaches 4 and 5, based on residual damage water surface profiles.

The following table shows residual damages by decade, reach, and damage category for the with-project condition. Ecuivalent annual damages with the project are $419,000, or 17 percent of the damages without the project.

Equivalent annual damages with project at Chaska
(October 1981 prices, 7 5/8-percent discount rate)

Damage categories	Study year 1980	Base year 1986	Decade years 10 1995	20 2005	30 2015	40 2025	50 2035	End of period 2085	Equivalent annual damage
Reach 1 = Minnesota River flooding									
Residential	71	79	92	105	120	129	133	133	96
Commercial	10	10	11	11	12	13	13	13	11
Public	45	47	49	51	53	53	57	57	50
Total	126	136	152	167	185	195	203	203	157
Reach 2 = Chaska Creek direct flooding									
Residential	2	3	6	15	23	34	41	41	11
Commercial	0	0	0	0	0	0	0	0	0
Public	1	1	1	1	1	1	1	1	1
Total	3	9	7	16	24	35	42	42	12
Reach 3 = Ponding behind existing levee from Chaska Creek overbank flows									
Residential	8	10	11	15	21	38	58	58	15
Commercial	1	1	1	1	1	2	3	3	1
Public	1	1	1	1	1	2	3	3	1
Total	10	12	13	17	23	42	64	64	17
Reach 4 = East Creek flooding, upstream of Highway 212									
Residential	117	126	139	153	167	171	171	171	143
Commercial	64	64	64	64	64	64	64	64	64
Public	19	19	19	19	19	19	19	19	19
Total	200	209	222	236	250	254	254	254	226
Reach 5 = East Creek flooding, downstream of Highway 212									
Residential	6	6	7	8	9	9	9	9	7
Commercial	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0
Total	6	6	7	8	9	9	9	9	7
Total, all reaches									
Residential	204	224	255	296	340	381	412	412	272
Commercial	75	75	76	76	77	79	80	80	76
Public	66	68	70	72	74	75	80	80	71
Total	345	367	401	444	491	535	572	572	419

FLOOD DAMAGE REDUCTION BENEFITS

Flood damage reduction benefits are the difference between damages without and with the project. The proposed measures have equivalent annual benefits of $2,005,000. Benefit summaries by reach and by category are presented below for the base year, year 2035, and equivalent annual conditions. Also shown is a table listing the number and value of structures and flood depths for the with-project floodplain.

Average annual flood damage reduction benefits at Chaska by reach
(October 1981 prices, 7 5/8-percent discount rate)

Reach	Base year (1986)	Future conditions (2035)	Equivalent annual benefits	Percentage of total equivalent annual benefits
1	$ 473,000	$ 643,000	$ 529,000	26.4
2	415,000	1,280,000	656,000	32.7
3	105,000	444,000	175,000	8.7
4	514,000	940,000	639,000	31.9
5	3,000	12,000	6,000	0.3
Total	1,510,000	3,319,000	2,005,000	100.0

Average annual flood damage reduction benefits at Chaska by category
(October 1981 prices, 7 5/8-percent discount rate)

Category	Average base year (1986)	Future conditions (2035)	Equivalent annual benefits	Percentage of total equivalent annual benefits
Residential	$1,308,000	$2,988,000	$1,770,000	88.3
Commercial	33,000	85,000	47,000	2.3
Public	169,000	246,000	188,000	9.4
Total	1,510,000	3,319,000	2,005,000	100.0

Summary data on Chaska floodplain, with project

Floodplain	Number of structures: Residential	Commercial	Public	Total structure value (1,000's)	Maximum flood depths 1-percent chance event (feet)
Minnesota River	0	0	0	$ 0	0
Chaska Creek	0	0	0	0	-
Within Minnesota River floodplain	(0)	(0)	(0)	(0)	0
Outside of Minne-ota River flood-plain	(0)	(0)	(0)	(0)	0
East Creek	71	12	0	7.7	-
Within Minnesota River floodplain	(13)	(0)	(0)	(0.6)	2
Outside of Minne-sota River flood-plain	(58)	(12)	(0)	(7.1)	3
Total	71	12	0	7.7	-
Percentage reduction from existing conditions	85	67	100	78	-

RELATED BENEFITS

SAVING OF FLOOD INSURANCE ADMINISTRATIVE COSTS

Two hundred forty-seven structures in Chaska are currently enrolled in the Flood Insurance Program. If the project were in place, an estimated 205 of these policies (83 percent) would be canceled. (The total number of floodplain structures is reduced 83 percent with the project.) Savings would result to the Nation because resources used for administrative work would become available for other work.

A January 1982 memorandum from the Federal Emergency Management Agency listed administrative costs at an average of $63 per policy. Therefore, average annual flood insurance administrative cost savings would be $13,000 (205 x $63) with the proposed project.

LAND DEVELOPMENT BENEFITS

In cases where a project alters the cost or pattern of new development in the floodplain, the project's effect on land income can be a project benefit. These benefits are generally evaluated using land market value data.

However, the Chaska floodplain is fully developed, and the project is not expected to affect future use of the floodplain. Therefore, the project does not have location, intensification, or flood proofing cost savings benefits.

FREEBOARD BENEFITS

Freeboard benefits have not been claimed in this report. The analysis was done according to previous regulations which did not allow for freeboard benefits.

LOCAL EMPLOYMENT

The social cost of a project is less than the market contract cost in situations where otherwise employed or underemployed labor resources are used for project construction. The opportunity cost of employing such workers is equal to the value of their forgone leisure time. Because society does not give up any alternate production and because it would be difficult to measure the value of leisure time forgone, the real cost of using otherwise unemployed workers is usually assessed as zero.

The unemployment rate for the Twin Cities metropolitan area has been between 4.2 and 5.3 percent in the last year. Hence, the area does not have "substantial and persistent unemployment" as defined by the Economic Development Administration, U.S. Department of Commerce, under subsection 1 of Title IV of the Public Works and Economic Development Act of 1965. Accordingly, the proposed project has no employment benefits.

RECREATION BENEFITS

The average annual benefits from recreation features of the project are $31,000. This number was derived from an update and a change in interest rate of the evaluation that appears in appendix 7.

BENEFIT-COST ANALYSIS

SUMMARY OF BENEFITS

National economic development benefits attributable to the proposed project include flood damage reduction, saving of flood insurance administrative costs, and recreation. Total equivalent annual benefits are $2,049,000, as summarized below.

Benefit summary
(October 1981 prices; 7 5/8-percent discount rate)

Benefit	Equivalent annual amount
Flood damage reduction	$2,005,000
Saving of flood insurance administrative costs	13,000
Recreation	31,000
Total	2,049,000

ANNUAL COSTS

Annual costs for the project are the sum of amortized first costs and annual operations and maintenance costs. First costs include no interest during construction because each separable feature of the project will be completed in one construction season.

Calculations below show annual costs to be $1,470,000.

Calculation of annual charges for the proposed project
(October 1981 prices: 7 5/8 percent discount rate)

Item	Amount
Federal and non-Federal first cost	$18,730,000
Interest during construction	0
Total investment cost	18,730,000
Interest and amortization ($18,730,000 x 0.07630)	1,429,000
Operation, maintenance, and replacement	
Flood control components	39,000
Recreation	2,000
Total annual charges	1,470,000

RELATIONSHIP OF BENEFITS TO COSTS

The project has net annual benefits of $579,000, a benefit-cost ratio of 1.39, and an internal rate of return of 10.25 percent. Break-even year, or the year in which annual benefits would exceed annual costs, is 1986, the base year, when the benefit-cost ratio is 1.11. A summary of these data is given below.

Benefit-cost analysis
(October 1981 prices; 7 5/8-percent discount rate)

Item	Amount
Equivalent annual benefits	$2,049,000
Annual costs	1,470,000
Net benefits	$ 579,000
Benefit-cost ratio	1.39
Internal rate of return	10.25 percent
Break-even year	1986 (base year)
Benefit-cost ratio for base year	1.11

EXECUTIVE ORDER 11988

Executive Order 11988 states that Federal agencies shall avoid to the extent possible the long- and short-term adverse impacts associated with occupancy and modifications of floodplains and avoid direct and indirect support of floodplain development wherever there is a practicable alternative. The order requires Federal agencies to provide leadership and take action to:

- Avoid the base floodplain unless it is the only practicable alternative. Practicable involves consideration of pertinent factors such as environment, cost, and technology.

- Reduce the hazard and risk of flood loss.

- Minimize the impact of floods on human safety, health, and welfare.

- Restore and preserve the natural and beneficial floodplain values.

- Avoid action in the floodplain that encourages, allows, serves, or otherwise facilitates additional floodplain development.

The proposed project at Chaska complies with the Executive Order. It would significantly reduce flood risk to existing development with measures that address the dual objectives of national economic development and environmental quality. The proposed measures represent the only practicable alternative. Appropriate consideration has been given in the planning process to nonstructural measures. Finally, since Chaska's floodplain is already considered completely developed, the project would not encourage additional floodplain development. Growth in Chaska will take place in the East Creek watershed in areas above the bluff line of the Minnesota River valley, but no change in floodplain development is expected with or without the proposed project.

EXECUTIVE ORDER 11990

The construction of the proposed project would lead to the loss and degradation of beneficial values of wetlands. The study area's wetlands and their values are described on pages 17-18 of the Final Environmental Impact Statement (FEIS) (July 1975) and in paragraphs 4.12 - 4.15 of the supplement.

Adverse impacts on wetlands that could result from implementation of the authorized flood control project are discussed on pages 32-36 of the FEIS and in paragraphs 5.10 - 5.12 of the supplement. Plan 8E, the least environmentally damaging plan; Plan 8, the recommended plan; and Plan 8N, the NED plan, are modified versions of the authorized plan which avoid impacting a 230-acre wetland. The levee extension feature around Courthouse Lake, common to all three of these plans, would cause destruction by filling of a 4-acre floodplain forest wetland (see plate "Areas of Potential Impact on Significant Resources" for its location).

The floodplain forest wetland is considered to perform functions important to the public interest. Primarily, it serves important natural biological functions by providing food chain production; general habitat; and nesting, spawning, rearing, and resting sites for aquatic or terrestrial wildlife species (see paragraphs 2.a.(3) and 6.c. of the Section 404(b) evaluation). Alternatives to the proposed project which would not be located in wetlands or would have less damaging impacts on wetlands were evaluated on the basis of factors relevant to the study, including flood damage prevention, economics, aesthetics, general environmental concerns, fish and wildlife values, land use, recreation, water quality, health and safety, whether the action is functionally dependent on being located in an aquatic environment to fulfill its basic purpose, and the needs and welfare of the people.

Alternatives for flood damage reduction are described in the Phase I General Design Memorandum (pages 37-42) and the FEIS (pages 41-54). Alternatives which would not disrupt wetland areas were eliminated from further study because they did not meet the study planning objectives, were socially or environmentally unacceptable, or were not economically feasible.

Throughout the Chaska flood control study, opportunity for public review of alternatives which would affect wetlands has been provided. The study's public involvement program has complied with ER 1105-2-502 and ER 1105-2-800.

Based on results of the study and in close coordination with appropriate agencies and the public throughout the planning process, Plan 8 is the recommended plan. It was determined to be the most responsive to the national and specific planning objectives and evaluation criteria. Although Plan 8 would cause the unavoidable destruction of a 4-acre wetland, it also incorporates modifications of the authorized plan which would avoid affecting other wetlands of public concern.

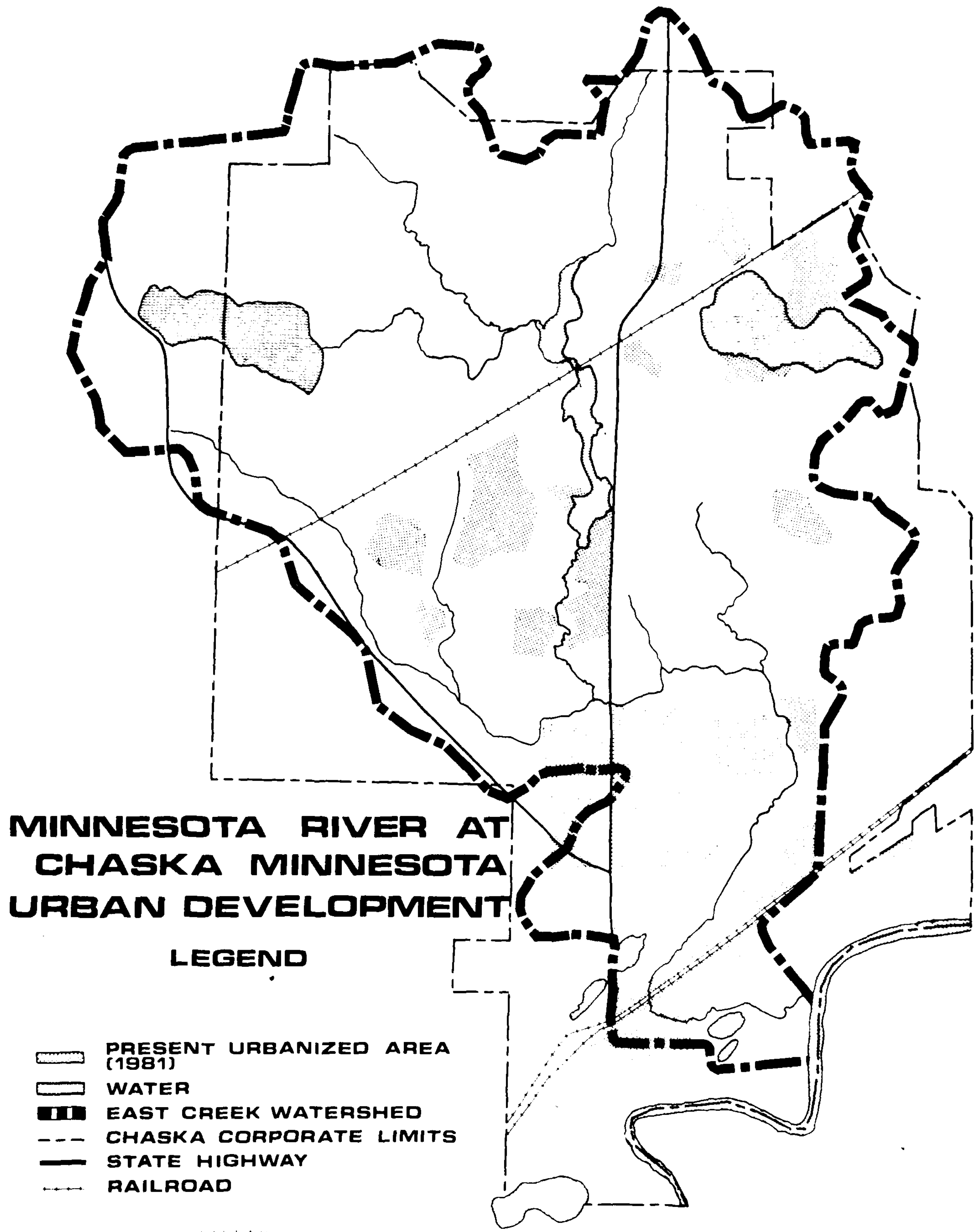

MINNESOTA RIVER AT
CHASKA MINNESOTA
URBAN DEVELOPMENT
LEGEND
PRESENT URBANIZED AREA (1981)
WATER
EAST CREEK WATERSHED
CHASKA CORPORATE LIMITS
STATE HIGHWAY
RAILROAD

PLATE 10-1

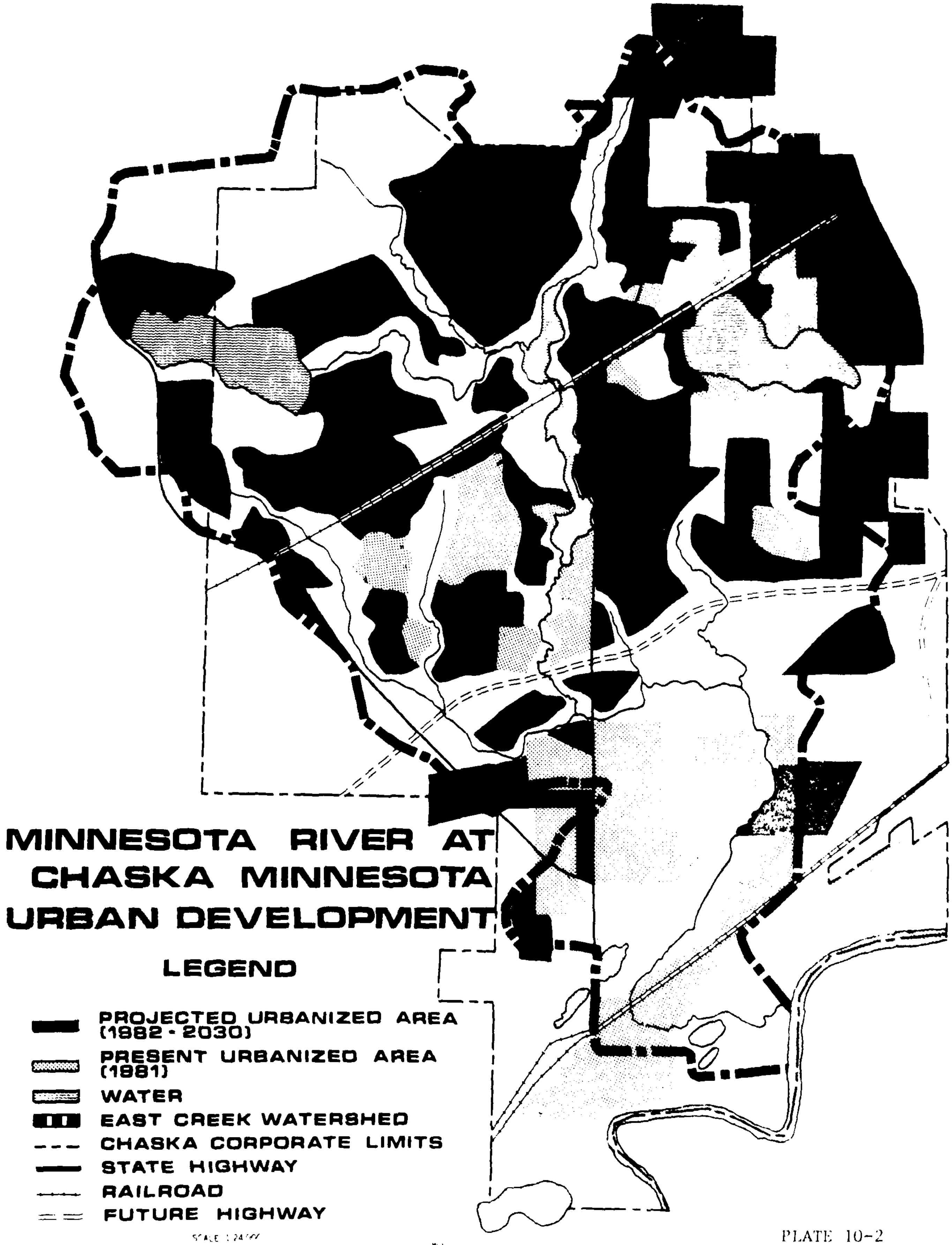
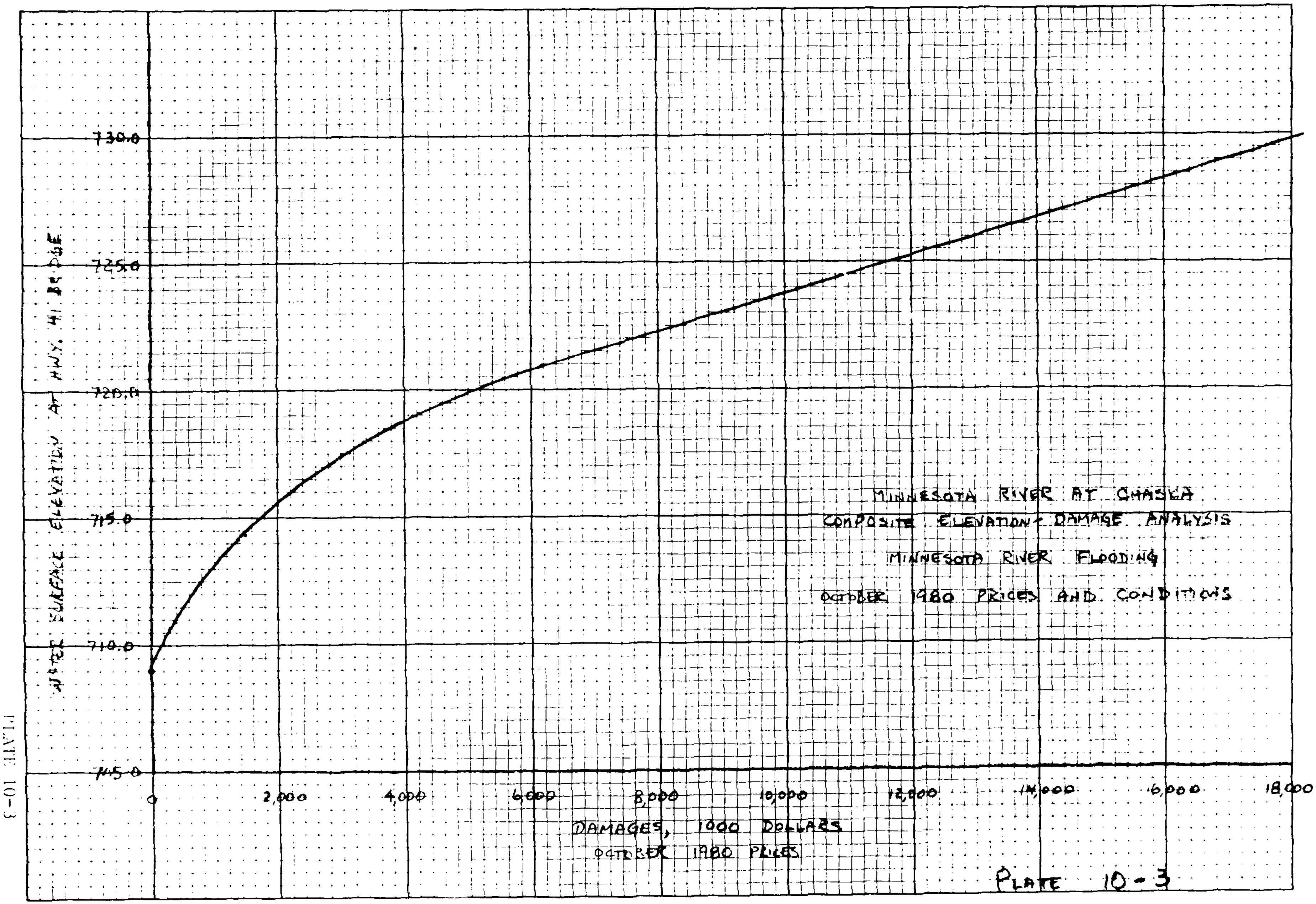
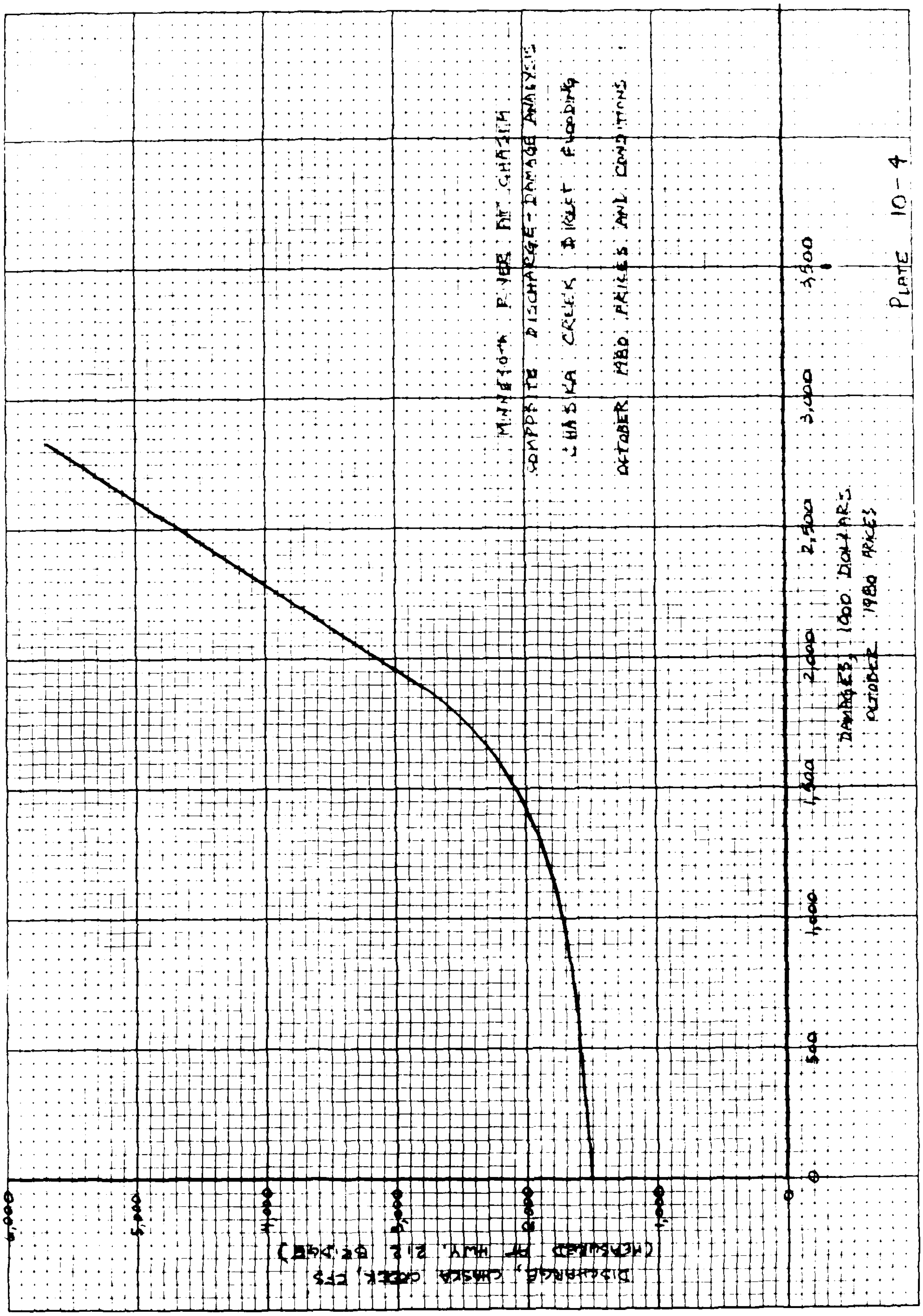


PLATE 10-2

☆ U S GPO 1981 765 057/1031 6



MINNESOTA RIVER AT CHASKA
COMPOSITE ELEVATION-DAMAGE ANALYSIS
MINNESOTA RIVER FLOODING
OCTOBER 1980 PRICES AND CONDITIONS
WATER SURFACE ELEVATION AT HWY. 41 BRIDGE
730.0
725.0
720.0
715.0
710.0
705.0
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
DAMAGES, 1000 DOLLARS
OCTOBER 1980 PRICES
PLATE 10-3


MINNESOTA RIVER AT CHASKA
COMPOSITE DISCHARGE-DAMAGE ANALYSIS
CHASKA CREEK DIKE FLOODING
OCTOBER 1980 PRICES AND CONDITIONS
0
500
1,000
1,500
2,000
2,500
3,000
3,500
DAMAGES, 1000 DOLLARS
OCTOBER 1980 PRICES
1,000
2,000
3,000
4,000
5,000
6,000
DISCHARGE, CHASKA CREEK, CFS
(MEASURED AT HWY. 212 BRIDGE)
PLATE 10-4

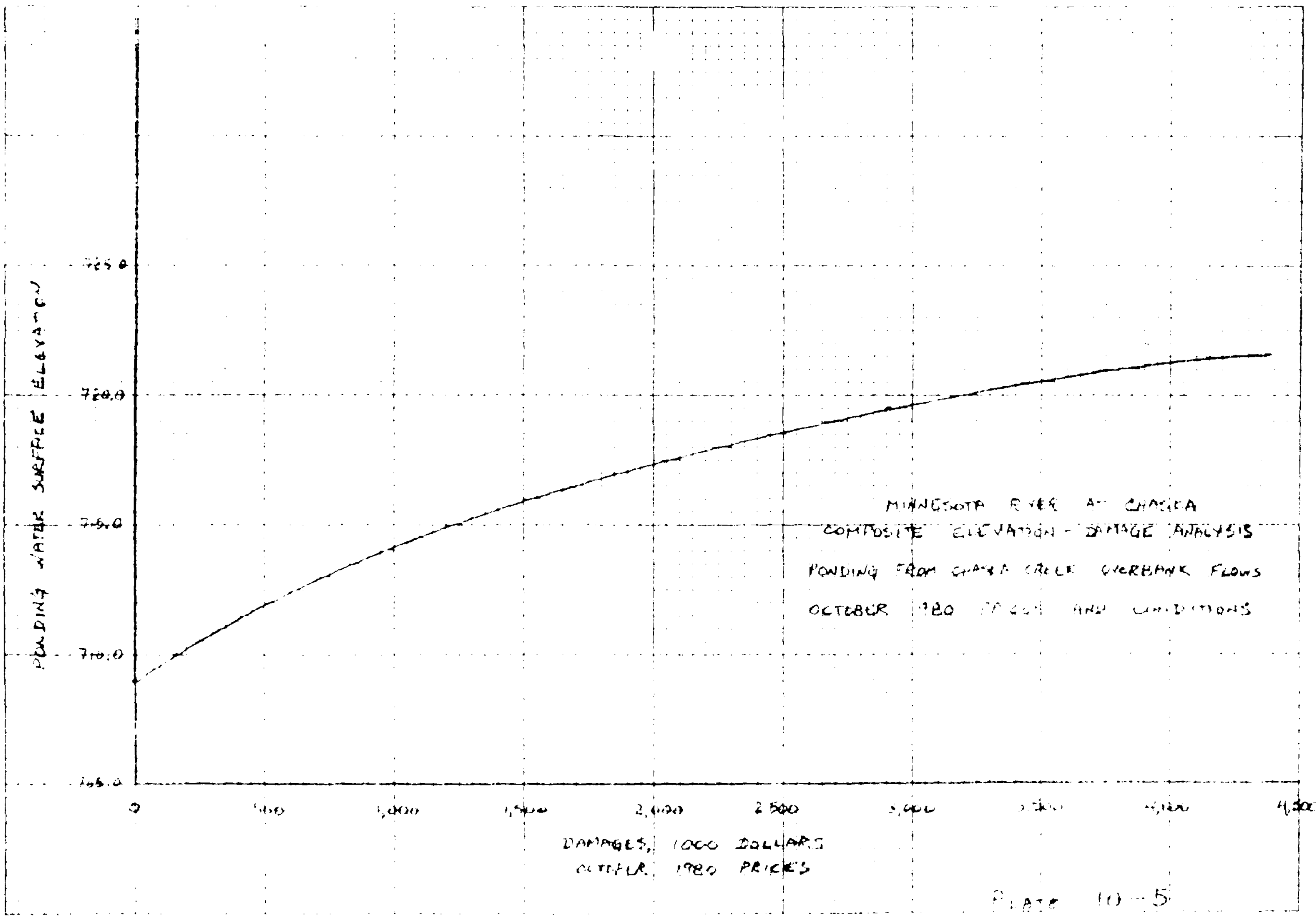

MINNESOTA RIVER AT CHASKA
COMPOSITE ELEVATION - DAMAGE ANALYSIS
PONDING FROM CHASKA CREEK OVERBANK FLOWS
OCTOBER 1980 PRICES AND CONDITIONS
PONDING WATER SURFACE ELEVATION
725.0
720.0
715.0
710.0
705.0
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
DAMAGES, 1000 DOLLARS
OCTOBER 1980 PRICES

PLATE 10-5

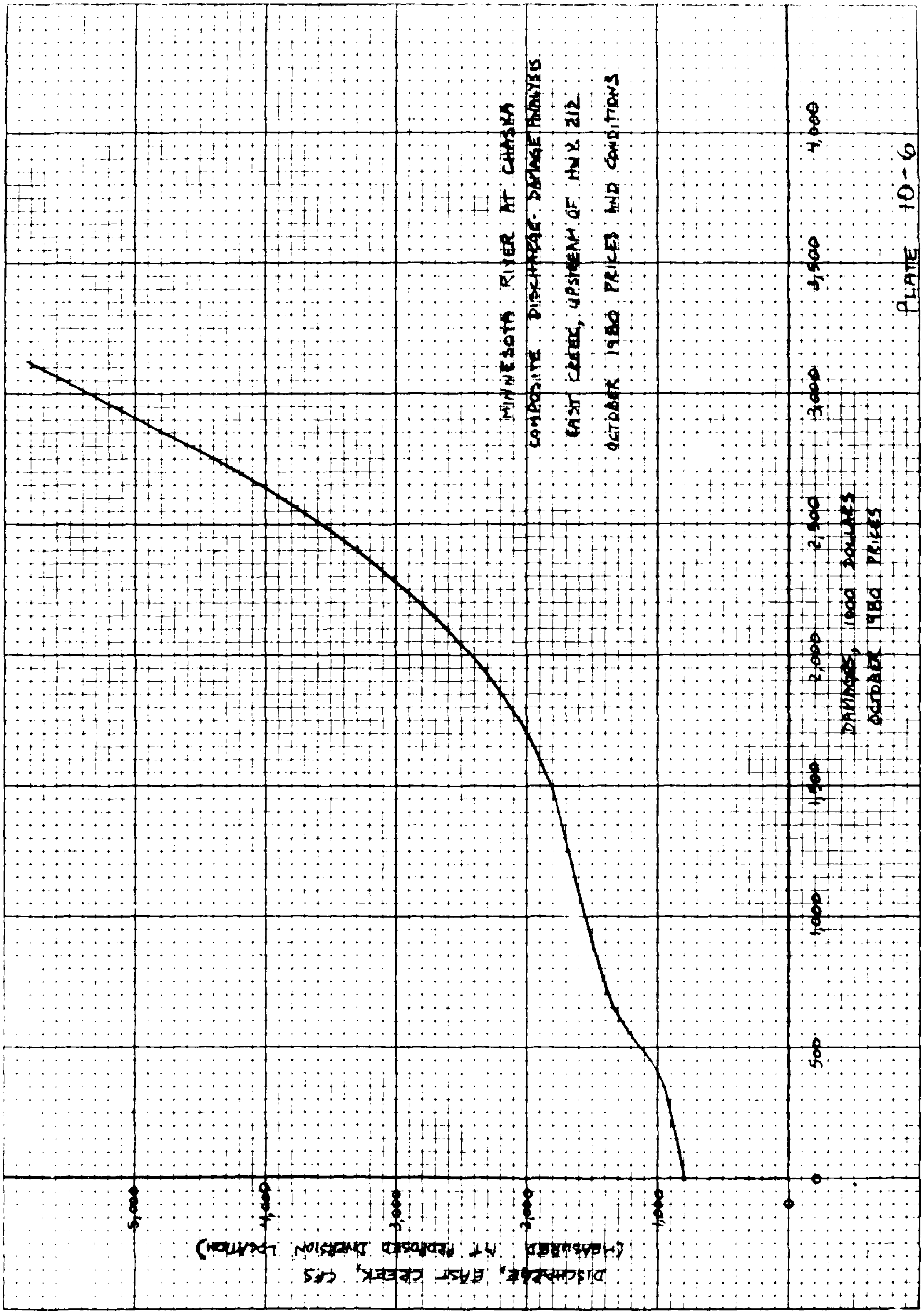
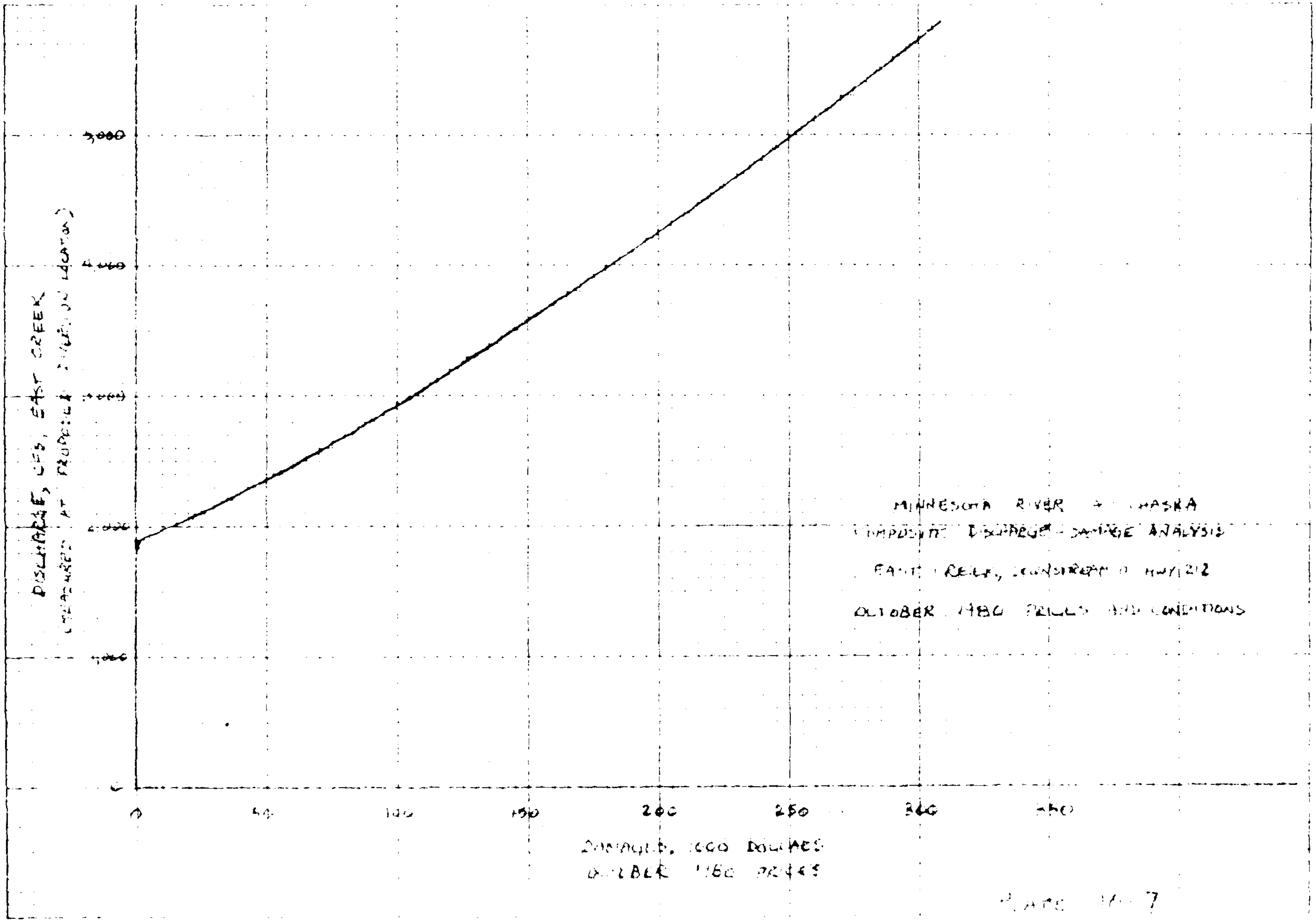

MINNESOTA RIVER AT CHASKA
COMPOSITE DISCHARGE-DAMAGE ANALYSIS
EAST CREEK, UPSTREAM OF HWY 212
OCTOBER 1980 PRICES AND CONDITIONS
DAMAGES, 1000 DOLLARS
OCTOBER 1980 PRICES
DISCHARGE, EAST CREEK, CFS
(MEASURED AT PROPOSED DIVERSION LOCATION)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
1,000
2,000
3,000
4,000
5,000
PLATE 10-6

PLATE 10-6


MINNESOTA RIVER AT CHASKA
COMPOSITE DISCHARGE-DAMAGE ANALYSIS
OCTOBER 1980 PRICES AND CONDITIONS
DISCHARGE, CFS, EAST CREEK
0
50
100
150
200
250
300
350
DAMAGES, 1000 DOLLARS

1

FISH & WILDLIFE

APPENDIX

LIMITED REEVALUATION REPORT

MINNESOTA RIVER AT CHASKA, MINNESOTA

11

PREPARED BY THE

DEPARTMENT OF THE ARMY

APPENDIX 11

FISH AND WILDLIFE

EXHIBITS

MINNESOTA DEPARTMENT OF [illegible]
DIVISION OF [illegible] SECTION [illegible]

REHABILITATION PROPOSAL WORK SHEET

Lake [X] Stream [ ] Treatment No. [2] Date of last treatment 1967

1. Lake or Stream name(s) Courthouse County Carver

S. 4,9 T. 115 R. 23 Div. of Waters, Soils & Minerals I.D. No. 10-5

2. ~~Miles~~ or Acres: 9.86 % Littoral 30.9 Source of information: DNR Sounding Map

3. Date lake sounded: 1964 Max. depth: 57 ft. Method used: Sonar

4. Previous Surveys; when and by whom: Lake survey-1967; Temp/Oxy-1977; Pop. asses.-1978-DNR.

5. Public access; Ownership and location: County land surrounds entire lake.

6. Need for rehabilitation and fish population problem: Courthouse Lake is a designated stream trout lake in which a population of undesirable warmwater fish has developed.

FIELD SURVEY (Conducted prior to treatment)

1. Date: ____ By: ____

2. Stream flow detail (temperature required for trout streams)

Lake Inlet or Stream Name	Location Sec.	Twp.	Rge.	T.A. ppm.	Temp. (°F)	Vol. of flow c.f.s.	Av. rate of flow f.s.	Date

3. Lake Outlet name None Flow ____ c.f.s. Flows to ____

4. Barrier; Location and type ____

5. Lake water quality Date 8/5/77

Depth	S	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Temp	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2
[illegible]	8.3	8.2	8.2	7.8	7.9	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.9	8.0	7.9
[illegible]	20	25	30	35	40	45										
[illegible]	56.2	52.3	46.8	[illegible]	41.9	41										
	10.4	[illegible]	4.4	[illegible]	[illegible]											

[illegible] 110 [illegible] 2.8 Secchi disk 7 ft. [illegible]

6. Fish population check

Gear used 3/4" trap net

Gear effort 4 overnight sets (10/10-11/78)

Species	No. taken	Gear	Relative Abundance	Av. length and weight
Rainbow trout	3	Trap Net	Low	1.03 lb 10-18"
Lake trout	1	"	"	1.9 lb 17"
White sucker	1	"	"	2.0 lb 17"
Golden shiner	2	"	High	.1 lb 5-6"
Large mouth bass	3	"	"	.1 lb 4-7"
Green sunfish	7	"	"	.1 lb 3-7"
Pumpkinseed	2	"	Low	.15 lb 5-6"
White crappie	19	"	High	.17 lb 6-10"
Black crappie	7	"	Ave.	.3 lb 5-9"

Other species present Yellow perch

7. Endangered species present None

8. List sources (maps, etc.) used to check watershed U. S. G. S. topographic quadrangle

9. Remarks (history of management and angler success) Past creel census data indicates that heavy fishing pressure has existed since management as a stream trout lake was initiated. The lake was rehabilitated with rotenone in 1967 to eliminate a warm water fish population. Warm water fishes are able to enter the lake at flood periods of the Minnesota River. Present flood control plans for the City of Chaska will give 100 year flood protection (20 year occurrence). Plans also include protection of water quality. Besides a detrimental effect which the warm water fish have on the trout population, there are also associated enforcement problems. The major problem is that people fish Courthouse Lake for the warm water species prior to trout opening. Attached is the stocking record for Courthouse Lake along with other pertinent data.

[illegible]

2. Stocking recommendations:

Species	Number	Size	Season and year of stocking	Source	Est. Cost	
Rainbow trout	2,000	Yearling	Spring, 1981	State Hatchery	1500.00	

Continued annual stockings at this number until such time as chemical treatment again becomes necessary.

Total est. cost 1500.00/year

3. Anticipated annual fishing 100 man trips/acre/yr.

Submitted by: Edward [illegible] Title Area Fisheries Mgr. Date 3/31/81

Regional Manager: [illegible] Date 4/1/81

Approved: by: Donald E. Woods Date 4-3-81

Department Commissioner - By: Director, Division of Game and Fish

Special recommendations or regulations Regulations such as are normally applied to stream trout lakes.

CHEMICAL TREATMENT

1. Lake Volume Detail / Toxicant Detail

[illegible]	Acre-feet	Type of chemical	Amount
0-10'	89.45	Rotenone (Pro-Noxfish: 2½%)	91.24 gal
10-15'	36.95		37.69
15-20'	31.27		31.89
20-30'	50.38		51.39
30-40'	32.73		33.38
40-50'	15.79		16.1
50-57'	2.19		2.23

Total Acre-feet 258.76 Concentration 3.0 (ppm. or ppb.)

2. Stream Volume Detail / Toxicant Detail

Name	Distance	Acre-feet	Type of chemical	Amount

Total Acre-feet ____________ Concentration ____________ (ppm. or ppb.)

3. Total amount of chemicals to be used: 291 gallons (includes 10% average for changes in water levels, storm sewers)

4. Proposed treatment dates Fall, 1981

5. Method and number of applications 1 application utilizing boat bailers and pumps for deep water areas.

6. Estimated period of toxicity 3-4 weeks

7. Percent kill desired on target species 100%

8. Proposed detoxification procedure, if any None necessary

9. Measures to protect downstream fishery or other resources that may be affected None necessary

10. Any uses of treated waters for domestic, industrial, or agricultural purposes None

11. Remarks ____________

BENEFIT-COST CONSIDERATION WORK SHEET

COURTHOUSE LAKE

COST

LAND COST	0.00
DEVELOPMENT COST	0.00
REHABILITATION COST	
Labor & Equipment	431.56
Chemical (291 gallons at $12.00 per gallon)	3492.00
Fish Stocking for 10 year project life (production & distribution)	15000.00
SUBTOTAL	$18923.56
Amortized Cost (10 yrs.)	1892.36
ADMINISTRATIVE OVERHEAD	43.16
TOTAL AMORTIZED COST	$1935.52

BENEFIT

1. ANTICIPATED PROJECT LIFE	10 Years
2. ANTICIPATED FISHING PRESSURE	98 man trips/ac/yr
3. Monetary value assigned 1 man trip	$3.00
4. 9.86 acre lake will provide 966.3 man-trips per year at $3.00 per trip	$2898.90 per year benefit

BENEFIT-COST RATIO

The benefit-cost ratio for this project is 1.497:1 and is considered favorable.

1. Physical Features

I.D. No. (DOW Bull. No 25): 10-5
Legal Description: Twp. 115N, Rge. 23W, Sec. NW9
Surface Area: 9.7 acres
Littoral Area: 3.0 Acres
Percent Littoral Area: 30.93%
Length of Soreline: 0.6 miles
Greatest Length: 0.21 miles
Volume: 261 acre-feet (from 1964 DNR sounding map & 1967 water levels)
Maximum depth: 57 feet
Mean depth: 26.9 feet

2. Chemical Features

Water Chemistry (Samples taken on 7/11/67)

Parameter*	Surface	12 feet	25 feet
Sulfate ion	63	63	63
Total Phosphorus	0.06	0.039	0.062
Total iron	0.05	0.04	0.04
Cloride ion	11.5	11.5	12.0
Ammonia nitrogen	0.075	0.075	0.1
Nitrite nitrogen	0.002	0.002	0.008
Nitrite Mitrogen	0.02	0.01	0.2
T.K.N.	0.82	0.93	0.74
pH	8.8	8.2	7.7
Total Alkalinity	110	120	135

* in p.p.m. except for pH

Temperature - Dissolved Oxygen Profiles

See attached pages. Temperature is in degrees Celsius and dissolved oxygen in p.p.m. Dissolved oxygen in (   ).

Water Clarity

Date	Secchi disc reading (feet)
9/4/64	5.67'
7/6/67	5.5'
8/2/67	5.1'
7/1/68	10.0'
7/30/68	11.5'
9/17/69	2.75'
10/27/70	7.0'
7/17/75	10.42
8/5/77	17.1'
10/10/78	16.0'

Winter Dissolved Oxgen Levels (p.p.m.)

Date	Depth of Sample	Dissolved Oxygen	Depth of Lake
12/28/66	3'	9.8 p.p.m.	---
12/28/66	25'	11.0 p.p.m.	---
2/14/67	3'	6.9 p.p.m.	25'

Winter Dissolved Oxygen Levels (p.p.m.) cont.

Date	Depth of Sample	Dissolved Oxygen	Depth of Lake
2/14/67	3'	5.7 p.p.m.	25'
2/28/67	6'	4.6 p.p.m.	More than 30'
2/28/67	12'	5.0 p.p.m.	More than 30'
2/28/67	18'	5.2 p.p.m.	More than 30'
3/2/72	3'	8.5 p.p.m.	---
3/2/72	12'	7.2 p.p.m.	---
3/2/72	20'	7.2 p.p.m.	---

3. Fish Population Information

Year	Type of Gear	Fish Species Present
1964	Verbal report of fish caught by angling.	Sunfish, crappies, largemouth bass, northern pike, carp
1967	Trap net & seine	Bluegill, fathead minnow, common shiner, black bullhead, black crappie, white crappie, yellow perch
1967	Following rotenone treatment these fish species were found dead	Carp, gizzard shad, largemouth bass, buffalo, bullhead, black crappie, white crappie, white bass, bluegill, walleye
1968	Seine	Fathead minnow
1968	Creel Census	Rainbow trout, brown trout
1970	Trap Net	Spotfin shiner, fathead minnow, common shiner, green sunfish, yellow perch, rainbow trout
1978	Trap Net	Rainbow trout, lake trout, white sucker, golden shiner, largemouth bass, green sunfish, pumpkinseed, white crappie, black crappie.

4. Fish Management

Background investigations 1964-1967
Treated with rotenone: 1967
Initial rainbow trout stocking: 1967
Creel Census: 1968
Flooded by Minnesota River: 1969
Test Netted: 1970 & 1978

[illegible] an established [illegible] of 2,000 [illegible] annually. In addition various other coldwater species of trout and [illegible] have been stocked. These fish have been display fish at the State Fair, surplus fish from state hatcheries (principally St. Paul and Lanesboro) or gifts to the DNR from private citizens. The reason for putting display fish in Courthouse Lake is that once these fish have been removed from a hatchery, they are not returned to eliminate the chance of disease introduction. Courthouse Lake is one of the few locations in the Metro Region where these fish can be stocked and have a reasonable chance of survival.

Rainbow Trout Yearling Stockings

Year	Number	Rate
1967	1637	3.21/lb
1968	3184	2.34/lb
1969	1857	3.66/lb
1970	1416	12.42/lb*
1971	2002	4.46/lb
1972	4298	2.82/lb
1973	2499	4.0/lb
1974	1750	5.0/lb
1975	2050	3.3/lb
1976	2000	3.38/lb
1977	1933	4.1/lb
1978	2000	5.0/lb
1979	2000	5.6/lb
1980	1714	3.4/lb

* These fish should be considered as fingerlings rather than yearlings.

Miscellaneous Fish Stockings

Year	Species	Rate	Size	Number	
1967	Rainbow trout	5lb	Adult	4	
1968	Brown trout	----	Yearling	500	
	Coho salmon	----	Adult	150	
1969	Rainbow trout	5.75 lb	Adult	16	
	Brown trout	4.39/lb	Yearling	501	
1970	Rainbow trout	----	Adult	8*	
	Rainbow trout	2.7 lb	Adult	74	(Donaldson)
	Rainbow trout	1.74 lb	Yearling	107	(Donaldson)
	Brown trout	----	Adult	10*	
1971	Rainbow trout	6.0 lb	Adult	5"	
	Brown trout	5.58/lb	Yearling	229	
	Coho salmon	10/lb	Fingerling	60*	
1972	Rainbow trout		Adult	3*	
	Brown trout		Adult	1*	
	Coho salmon		Fingerling	150*	
1973	Brown trout	2.5/lb	Yearling	1075	
1974	Rainbow trout	2.5 lb	Adult	2*	
	Brown trout	3.0 lb	Adult	3*	
	Brook trout	1.0 lb	Adult	4*	
	Splake	20/lb	Fingerling	150*	
1975	Rainbow trout		Adult	44	
	Brown trout	4.0/lb	Yearling	1074	
	Brown trout	40/lb	Yearling	75*	
	Brown trout	4 lb	Adult	7	

[illegible]	[illegible]	[illegible]	Yearling	[illegible]
	Brook trout		Fingerling	[illegible]
	Brook trout	1 lb	Adult	7*
	Lake trout	4 lb	Adult	9*
1977	Rainbow trout		Adult	95
1978	Rainbow trout		Adult	7*
	Rainbow trout		Adult	131
	Brown trout		Adult	7*
	Brook trout		Adult	7*
	Lake trout		Adult	9*
1979	Brook trout	2.7/lb	Adult	212

* Fish from State Fair display

Total Stockings (1967-80)

	Adult	Yearling	Fingerling	Total
Rainbow trout	390	28,924	1,416	27,016
Brown trout	28	3,379	---	3,407
Brook trout	230	75	120	213
Lake trout	18	---	---	18
Splake	---	----	150	150
Coho salmon	150	---	210	360
Total				31,164

6. Additional Information

Lake sounding map prepared in 1964.
Water backed up from the Minnesota River has flooded Courthouse Lake in 1952, 1953, 1965 and 1969.
Courthouse Lake was created by a clay mining operation and filled with water when a water vein was struck.
Courthouse Lake is a designated stream trout lake and is the only one of its kind in the seven county Metro Region.
Water clarity has increased markedly once the suspended clay settled out and the shoreline covered with vegetation.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

TWIN CITIES AREA OFFICE
530 Federal Building and US Court House
316 North Robert Street
St. Paul, Minnesota 55101

SEP 16 1981

Colonel William W. Badger
District Engineer, St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

This letter responds to your September 2, 1981 request for information on the presence of federally listed threatened or endangered species in the vicinity of a proposed flood control project for the City of Chaska, in Carver County, Minnesota.

A review of information available in our files indicates that no threatened or endangered species are currently listed to occur in Carver County. However, the endangered Higgin's Eye Pearly Mussel (Lampsilis higginsi) is listed to occur in the Minnesota River. Scanty information exists on the distribution of this species in the Minnesota River and many malacologists believe it to be extirpated from this river system.

In addition to these endangered species comments, information should also be solicited from Mr. Carrol Henderson, Minnesota Department of Natural Resources, relative to the occurrence of state listed species within the project area.

Should this action as now planned, be modified or altered, or should new information reveal impacts that may affect listed species or their critical habitat, you must reinitiate Section 7 consultation.

Sincerely yours,

James L. Smith
James L. Smith
Acting Area Manager

cc: Minn. DNR, St. Paul(Carrol Henderson)

United States Department of the Interior
FISH AND WILDLIFE SERVICE
TWIN CITIES AREA OFFICE
530 Federal Building and US Court House
316 North Robert Street
St. Paul, Minnesota 55101

IN REPLY REFER TO:

DEC 23 1981

Colonel William W. Badger
District Engineer, St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

The U.S. Fish and Wildlife Service has completed the attached draft Fish and Wildlife Coordination Act Report for the Chaska Flood Control Project in Chaska, Carver County, Minnesota. The report is based on the findings of a habitat evaluation conducted by a tri-agency team of biologists representing the Minnesota Department of Natural Resources, U.S. Army Corps of Engineers, and U.S. Fish and Wildlife Service. The team's analysis was conducted in accordance with the Service's Habitat Evaluation Procedures (HEP). This draft report is being submitted for review to enable the Corps' comments to be incorporated into the final Fish and Wildlife Coordination Act Report for the Chaska Flood Control Project.

The attached document is basically the final report of the tri-agency team. The Fish and Wildlife Service concurs with and adopts the findings and recommendations of the team as our draft Fish and Wildlife Coordination Act Report for the Chaska Project. The draft report recommends measures to avoid and minimize adverse impacts to selected habitats, recommends measures to improve project lands for wildlife purposes, and quantifies unavoidable habitat losses to be compensated. The tri-agency team also developed three alternative proposals to compensate for habitat losses. Implementation of any of these proposals would be acceptable to the Service as providing adequate compensation for unavoidable habitat losses from construction of the Chaska Flood Control Project. We are also agreeable to assuming operation and maintenance expenses for these proposals per the team's recommendation.

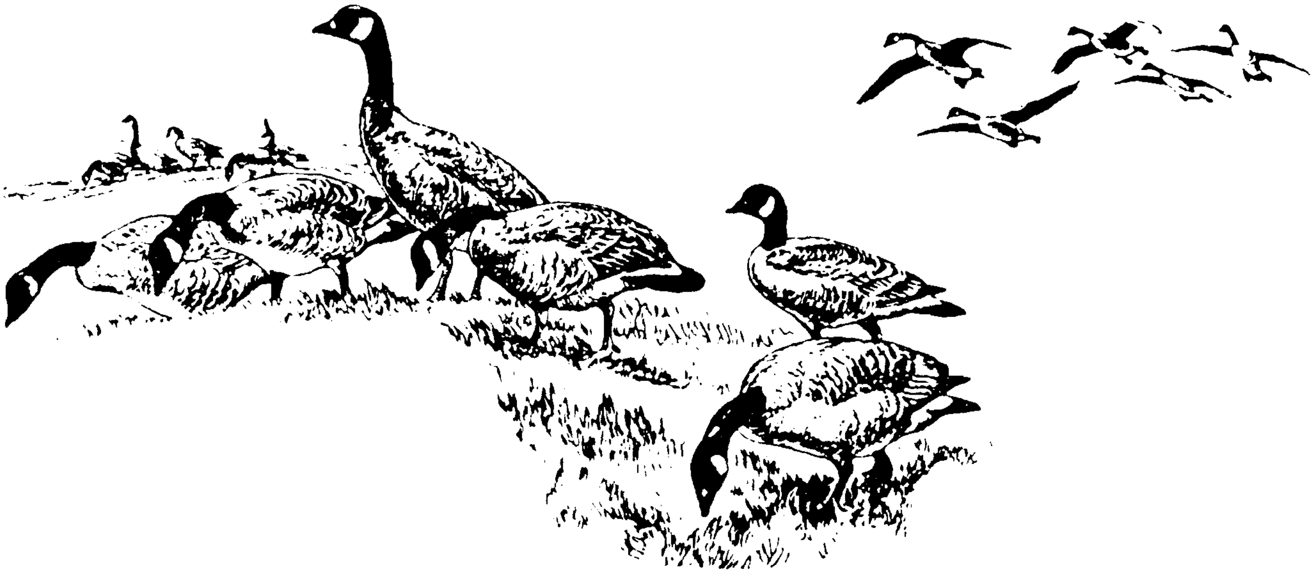
We look forward to receiving your comments on this report and our continued coordination on the Chaska project.

Sincerely yours,

George G. P. Bekeris
Area Manager

cc: MDNR, St. Paul

DRAFT fish and wildlife coordination act report



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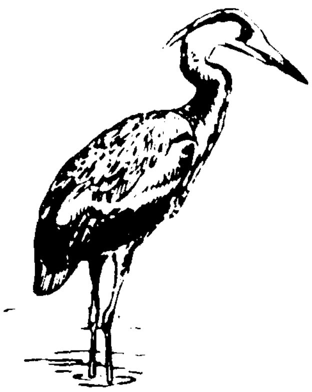
DEPARTMENT OF THE INTERIOR



Chaska Flood Control Project

December 1981

CHASKA FLOOD CONTROL PROJECT

CHASKA, CARVER COUNTY

MINNESOTA

Draft Fish and Wildlife Coordination Act Report

Submitted to the

U.S. Army Corps of Engineers

St. Paul District

St. Paul, Minnesota

United States Fish and Wildlife Service

Division of Ecological Services

St. Paul Field Office

December 1981

TABLE OF CONTENTS

SECTION I

Introduction

I. Introduction

This Fish and Wildlife Coordination Act (FWCA) report is based on results of a habitat evaluation conducted for the proposed Chaska Flood Control Project in Chaska, Carver County, Minnesota. On March 6, 1981, a planning aid report was submitted to the St. Paul District Corps of Engineers based on preliminary results of the evaluation. The primary objective of the report was to provide decision makers at the District with quantified information concerning project-related impacts to selected habitats for several alternatives under consideration at that time. The product of the report was a general ranking of these alternatives, based on their biological impacts, which was considered by District personnel in selecting final alignments. Final alignments subsequently selected by the District were identified in the report as those having the fewest adverse biological impacts.

The planning aid report phase of the evaluation represented one of the few times where the Service's Habitat Evaluation Procedures (HEP) were applied early in the planning process to provide impact-assessment information for use in the final selection of project features. The use of HEP in this manner is beneficial in that impact information in quantified terms is provided at an early stage of planning which can help to avoid many time-consuming conflicts during later stages.

This FWCA report quantifies project-related impacts to fish and wildlife resources, recommends habitat management measures to improve project lands for wildlife use, and recommends measures to minimize and compensate for unavoidable losses to valuable wildlife habitats based on the Fish and Wildlife Service's (FWS) mitigation policy. This draft report is being submitted for review to enable the Corps' comments to be incorporated into the final FWCA report for this project.

Description of Project

There are two components to the flooding problems at Chaska: (1) main stem flooding from the Minnesota River, and (2) flooding from tributaries (East and Chaska Creeks) to the Minnesota River. The selected solution to the first problem is the extension and renovation of the existing emergency levee (Figure 1). To reduce flood damages associated with East and Chaska Creeks, two diversion channels are proposed. The East Creek diversion channel will generally be a grassed channel which will divert flood flows; normal flows will continue in the existing East Creek channel. The proposed Chaska Creek diversion channel will generally be a concrete and riprap structure which will divert all existing flows through the channel.

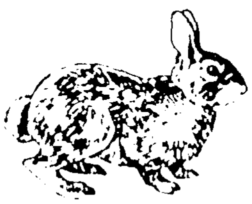
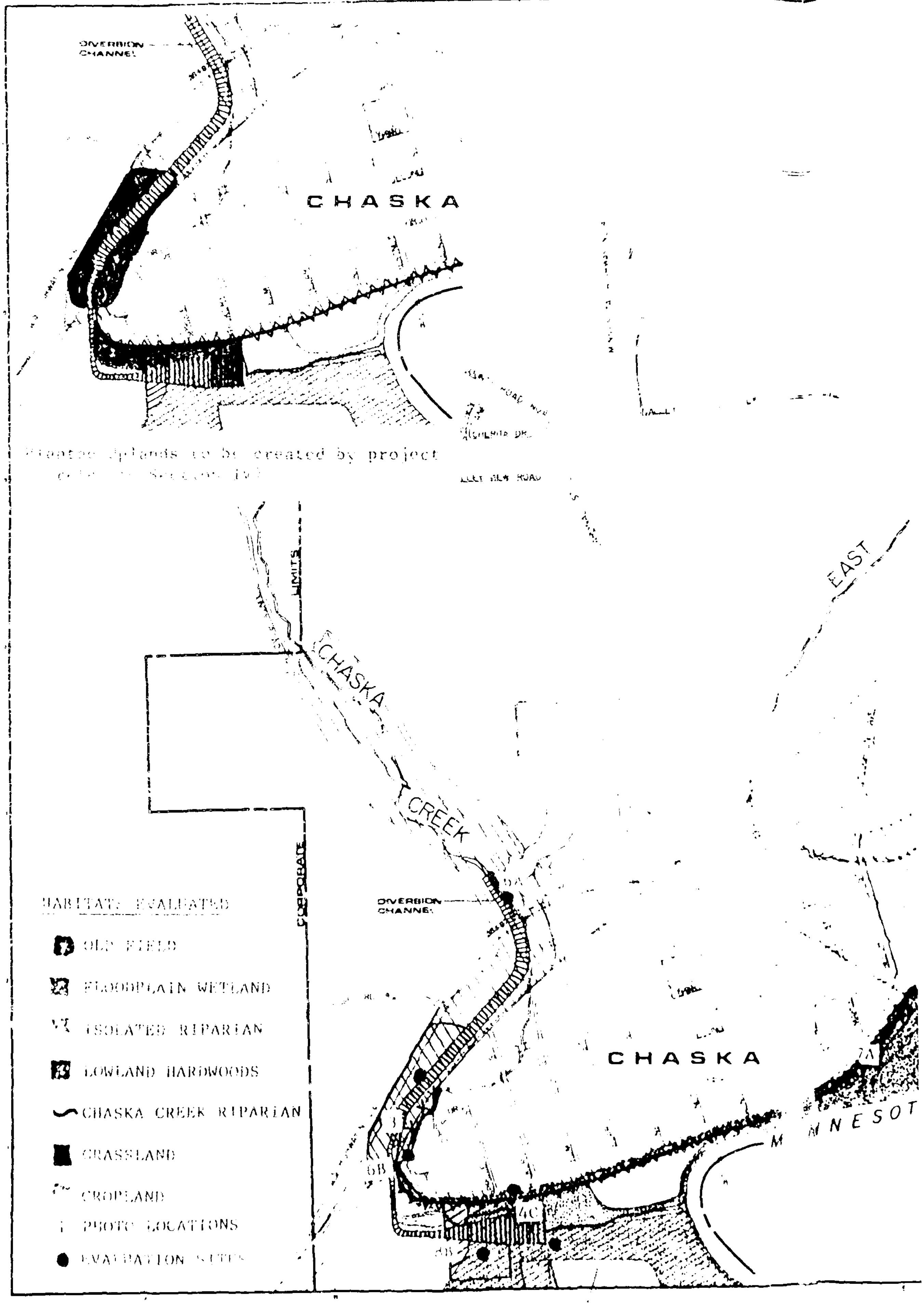
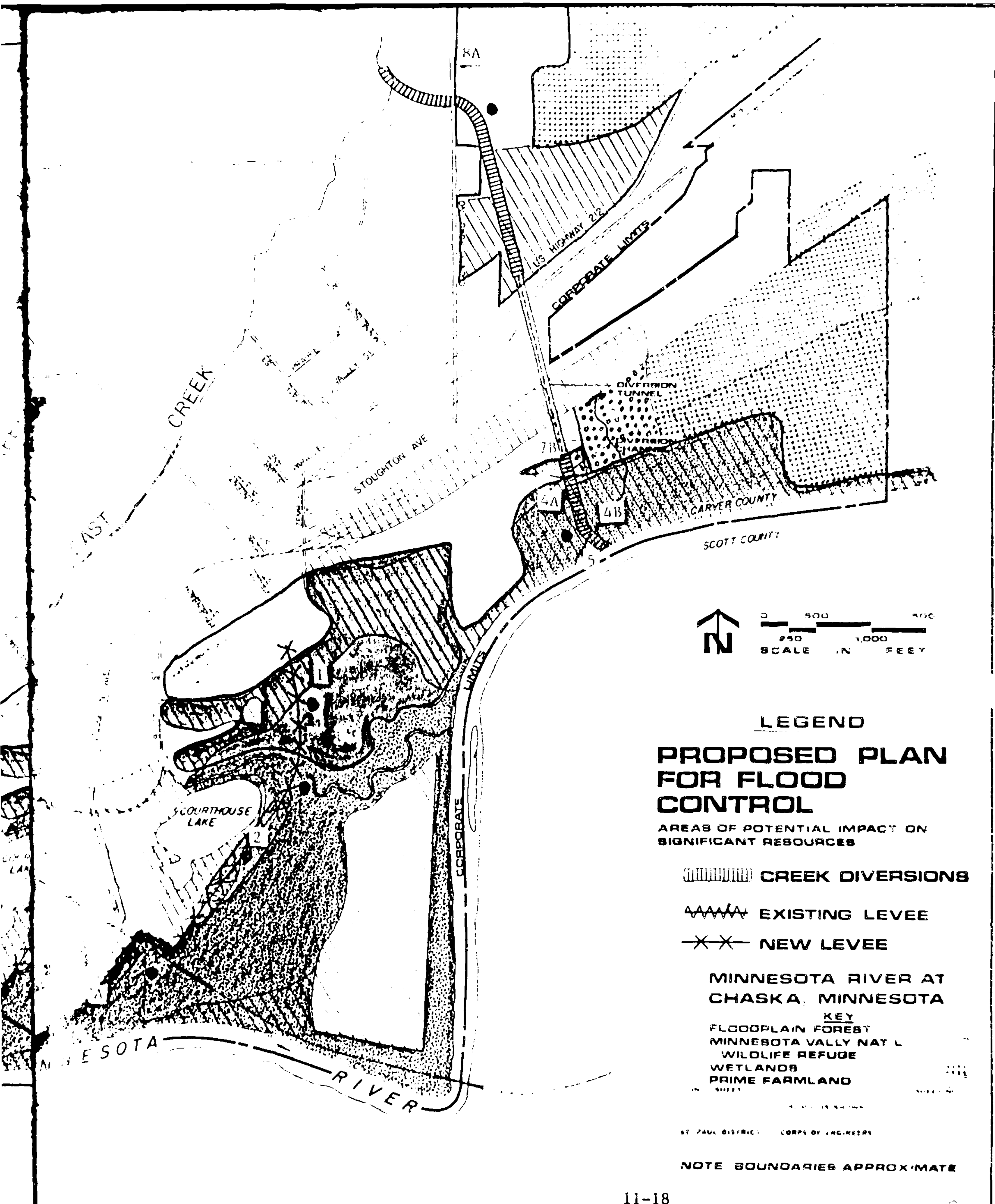


Figure 1. Habitat types evaluated for the Chaska Flood Control Project. Detailed maps are located at the St. Paul Field Office, U.S. Fish and Wildlife Service, 538 Federal Building, 316 North Robert Street, St. Paul, Minnesota 55101.


DIVERSION CHANNEL
CHASKA
CHASKA CREEK
LIMITS
CORPORATE
EAST
DIVERSION CHANNEL
CHASKA
MINNESOT
HABITAT EVALUATED
OLD FIELD
FLOODPLAIN WETLAND
ISOLATED RIPARIAN
LOWLAND HARDWOODS
CHASKA CREEK RIPARIAN
GRASSLAND
CROPLAND
PHOTO LOCATIONS
EVALUATION SITES
7A
6B
4C
4B



8A
US HIGHWAY 212
CORPORATE LIMITS
DIVERSION TUNNEL
CREEK
STOUGHTON AVE
7B
4A
4B
CARVER COUNTY
SCOTT COUNTY
5
1
2
COURTHOUSE LAKE
RIVER
CORPORATE LIMITS
250
1,000
SCALE IN FEET
LEGEND
PROPOSED PLAN FOR FLOOD CONTROL
AREAS OF POTENTIAL IMPACT ON SIGNIFICANT RESOURCES
CREEK DIVERSIONS
EXISTING LEVEE
NEW LEVEE
MINNESOTA RIVER AT CHASKA, MINNESOTA
KEY
FLOODPLAIN FOREST
MINNESOTA VALLY NAT L WILDLIFE REFUGE
WETLANDS
PRIME FARMLAND
NOTE BOUNDARIES APPROXIMATE

SECTION II

Methods

II. Methods

The habitat evaluation for the Chaska Flood Control Project was initiated in October, 1979 by a tri-agency team of biologists representing the Minnesota Department of Natural Resources, U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service. Evaluated in this report are selected alignments for the Chaska Creek diversion channel, East Creek diversion channel, and the levee renovation and extension (Figure 1).

The study area was delineated and field reviews conducted to identify and assess habitat types (Figure 1). Habitat types were delineated from 1978 color infrared aerial photographs corrected for subsequent land use changes. A zoom transfer scope was used to transfer habitat delineations from the photographs to 1:1200 base maps outlining the proposed project. A digital planimeter was used to determine acreages.

Habitat types were evaluated for terrestrial species using a combination of the FWS Habitat Evaluation Procedures (HEP). The 1976 version of HEP provided the basic format for the evaluation. Information from HEP-'80 was used to evaluate habitats for selected species (draft Terrestrial Habitat Evaluation Criteria Handbook For Ecoregion 2213).

Ten evaluation species were selected for each habitat type (Table 1). Several factors were considered in selecting these species. The primary consideration was the basic objective of the habitat evaluation -- to quantify project-related impacts to the ecological community within each habitat type. Evaluation species selected must be representative of these communities. The team also considered the fact that public use of wildlife resources in the project area were basically non-consumptive. Based on these considerations, evaluation species selected represent an ecological cross section of the faunal community of each

habitat type and include a mixture of mammals, birds, reptiles and amphibians (Table 1).

Most species and evaluation criteria came from the above referenced Handbook For Ecoregion 2213. The handbook provides a useful description of habitat requirements for selected species in this ecoregion. In general, the team used these descriptions to evaluate selected habitats. Suggested evaluation species for habitats were sometimes substituted (Table 1) because the team felt that some species suggested in the draft handbook were not representative of the Chaska area or particular habitats evaluated. Evaluation criteria for substituted species were based on reference materials on species' habitat requirements and the professional judgement of the team. Habitats were evaluated by identifying the existing characteristics of the habitat at each evaluation site and determining how well those characteristics fulfilled the habitat requirements of the selected evaluation species. Numerical ratings for each species in Table 1 were based on the limiting habitat requirement, if any, at each evaluation site. The team also considered disturbance factors associated with the adjacent urbanized area of Chaska, such as human activity, to adjust some ratings. In addition to quantifying values for existing habitats, the team also estimated habitat values for the proposed levee, diversion channels and associated rights-of-way. Numerical ratings for each evaluation species were based on a scale of 0-10.0 and Habitat Unit Values (HUV) on a scale of 0-100.

Study information was entered into the FWS Hewlett Packard programmable calculator using the standard HEP-'76 program. Annualized habitat units referenced in this report are units lost or gained per year over the project life of 100 years.

Table 1 Species used to evaluate selected habitats. [illegible] Numerical ratings are based on a scale [illegible] for each species. Habitat unit values [illegible] habitat. *Indicates species selected [illegible] for project lands are maximum values [illegible] illustrated in Figure 2.

HABITAT TYPE	HU	[illegible species columns]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Wood frog	[illegible]	[illegible]	[illegible]	Northern water [illegible]	American toad
OLD FIELD	[illegible]	[illegible]								8.5	8						
FLOODPLAIN WETLAND	[illegible]	[illegible]										5		10	5	10	
ISOLATED RIPARIAN	[illegible]	[illegible]									8						
LOWLAND HARDWOODS	[illegible]	[illegible]							7.8			5.5					
CHASKA CREEK RIPARIAN	[illegible]	[illegible]						5									
GRASSLAND	[illegible]	[illegible]				5					2.5						2
CROPLAND	[illegible]	[illegible]									3.8						
LEVEE 1/	[illegible]	[illegible]				5										2.5	2.5
GRASSED CHANNEL 1/	[illegible]	[illegible]				6			6	6							3
CONCRETE CHANNEL 1/	[illegible]	[illegible]				[illegible]			2	2							1
PLANTED UPLANDS 1/	[illegible]	[illegible]		4				5	8		8						
MOIST SOIL UNIT & IMPOUNDMENT	[illegible]	[illegible]									3.8						
CHASKA LAKE	[illegible]	[illegible]			6								5			5	
TYPE III WETLAND	[illegible]	[illegible]			10		6						8			6	
LOUISVILLE SWAMP	[illegible]	[illegible]											7			8	

SECTION III

Description of Habitats Sampled and Project Impacts

III. Description of Habitats Sampled and Project Impacts

The Chaska area contains a variety of habitats valuable to fish and wildlife (Figure 1). These areas are also used for public recreation such as wildlife observation and hiking. Most habitats within the project area are or have been influenced by the Minnesota River and East and Chaska Creeks. The following is a brief discussion of habitats that will be affected by the proposed Chaska Flood Control Project. Habitat Unit Values (HUV) shown are from Table 1. Appendix A contains photographs of each habitat type.

Old Field (HUV 81)

This typical field habitat is located northeast of Courthouse Lake and generally lies within the 100-year floodplain of the Minnesota River. Dominant vegetation includes staghorn sumac, willow, goldenrod, and grasses. A small pond is located on the area, with lowland hardwoods bordering to the south and east.

The proposed project will take approximately 2.3 acres of old field habitat for construction of the proposed levee extension. This includes the drainage ditch proposed along the western toe of the levee. In addition, approximately 10 acres will be used as a temporary ponding area behind the proposed levee. However, this designation was not considered by the team to generate adverse project impacts since land use will be regulated and the frequency of its use as a ponding area is low.

Floodplain Wetland (HUV 74)

This habitat can be described as a woodland pond within the lowland

hardwoods adjacent to the Minnesota River and is located immediately east of Courthouse Lake. Dominant vegetation includes scattered cattail and grasses bordered by silver maple and cottonwood. Water levels fluctuate seasonally and are generally less than 12 inches.

The southern portion of the original wetland area near the wastewater treatment facility has been partially filled by the City of Chaska. City personnel have been advised by the Regulatory Functions Branch of the St. Paul District regarding the need for a Department of the Army permit for any additional discharge of fill material into this wetland area. The entire 3.5-acre habitat will be used for the construction of the proposed levee near Courthouse Lake. This does not include the area already filled by the City of Chaska.

Isolated Riparian (HUV 73)

This former riparian habitat is presently separated from Chaska Creek by the Chicago-Northwestern railroad grade. Dominant vegetation includes silver maple, box elder, cottonwood, and elm with scattered red-osier dogwood, goldenrod and grasses.

The proposed Chaska Creek diversion channel will replace the entire 6.6-acre habitat.

Lowland Hardwoods (HUV 57)

Typical lowland hardwood habitat is located within the floodplain of the Minnesota River and is vegetated with silver maple, cottonwood, willow and elm with scattered nettle, jewelweed and grasses. This habitat generally forms a continuous corridor along the Minnesota River within the study area. A small stream flows through that portion proposed for construction of the East Creek diversion channel. Habitat

[illegible] Chaska Creek below the First Street Bridge was also [illegible] to lowland hardwoods.

All alignments will impact lowland hardwood habitat for a total loss of 17.7 acres. The proposed levee extension and Chaska Creek diversion channel will replace 10.0 and 1.7 acres, respectively. Lowland hardwoods located along Chaska Creek are within the Minnesota Valley National Wildlife Refuge. In addition, construction of the East Creek diversion channel will take 6.0 acres of lowland hardwood habitat, eliminate a small section of the stream mentioned earlier, and effectively bisect the presently continuous habitat in this area.

Chaska Creek Riparian (HUV 30)

Riparian habitat is located along Chaska Creek upstream from the First Street Bridge excluding areas of Chaska Creek that are concrete lined. This habitat type is essentially located in two distinct areas -- immediately upstream of the First Street Bridge and immediately upstream of the Highway 212 Bridge. Vegetation includes elm, box elder, silver maple, cottonwood, willow, nettle and grasses.

The proposed Chaska Creek diversion channel will replace all 2.0 acres of this habitat.

Grassland (HUV 33)

This short, grassy habitat is found generally on and along the existing levee. The habitat is disturbed from levee maintenance and use of the pedestrian trail located on the crest. Approximately 19.1 acres of grassland habitat will be used in the construction of the East Creek diversion channel and levee renovation.

Cropland (HUV [illegible])

Cropland habitat in the study area includes fields of corn, alfalfa and soybeans. Several fields are located adjacent to more valuable wildlife habitats (old field, lowland hardwoods) and provide some value to wildlife for food and cover. However, habitat values are reduced by fall plowing. All alignments utilize cropland habitat for a total loss of approximately 11.[illegible] acres.

Courthouse Lake

It was the decision of the team that adverse project-related impacts to fishery resources in the Chaska area did not warrant an extensive aquatic habitat evaluation. This decision was also influenced by the lack of suitable evaluation criteria for aquatic species for use with HEP.

Although Courthouse Lake was not evaluated in this study, the proposed Chaska project may have both beneficial and adverse impacts. Approximately 10 acres in size, Courthouse Lake is a former quarry pit that was reclaimed with fish toxicants in 1967 and is currently managed by the Minnesota Department of Natural Resources (MDNR) as a trout fishery. During the fall of 1981, Courthouse Lake was again treated with fish toxicants to remove undesirable species. In early 1982, the lake will be stocked with rainbow trout by MDNR to provide a coldwater sport fishery. Courthouse Lake has the distinction of being the only designated trout lake in the Twin Cities Metropolitan Area and is a unique and valuable resource which receives extensive public use.

The proposed levee renovation and extension will provide 100-year flood protection to Courthouse Lake from the Minnesota River. This increased level of flood protection is a beneficial aspect of managing the lake as a trout fishery since it would prevent the introduction of undesirable

fish species into the lake during flooding by the Minnesota River, a phenomenon which has occurred at least once since the lake was renovated in [illegible].

The selected plan would use Courthouse Lake and adjacent lands as emergency temporary ponding areas for the East Creek interior drainage system at Chaska. As addressed in MDNR Commissioner Joseph Alexander's letter of August 15, [illegible], such use may allow the introduction of undesirable fish species from East Creek floodwaters. Poor water quality of these floodwaters may also pose a threat to the coldwater fishery. However, the operating plan for ponding has been redesigned to minimize adverse water quality impacts to Courthouse Lake as much as possible. The probability of using Courthouse Lake as an emergency ponding area under the proposed plan is remote (100-year flooding frequency).

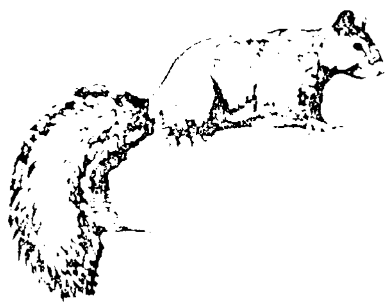
Minnesota Valley National Wildlife Refuge

An important development in recent years has been the establishment of the Minnesota Valley National Wildlife Refuge. The proposed Chaska Creek Diversion Channel would require approximately 7 acres of refuge lands. These lands include a mixture of lowland hardwood and field habitats. The proposed project will require the formal approval of the U.S. Fish and Wildlife Service with respect to its compatibility with the purposes for which the refuge was established. In addition to habitat impacts, the proposed channel will eliminate the present access road to the Chaska Lake Unit, a valuable wildlife management unit of the refuge, and eliminate the present refuge gate, fence, and field access. Relocation and replacement expenses should be assessed to the project. In addition, the proposed public parking area and [illegible] at the refuge entrance will likely require relocation due to the alignment of the proposed diversion channel. Close coordination must be maintained with the FWS during the final planning stages to develop a mutually acceptable project.

SECTION IV

Management Recommendations

for Project Lands



IV Management Recommendations For Project Lands

To improve project lands for wildlife use by providing additional food and cover, and to minimize compensation requirements, the team developed habitat management recommendations for levee, channel and other project lands. Habitat unit values assigned to these habitats and entered into the HEP-'76 program were based on the adoption of these recommendations by the Corps as project features. Therefore, Habitat Unit Values (HUV) assigned to project lands can be considered as optimal values. Management recommendations are illustrated in Figure 2.

Levee (HUV 37)

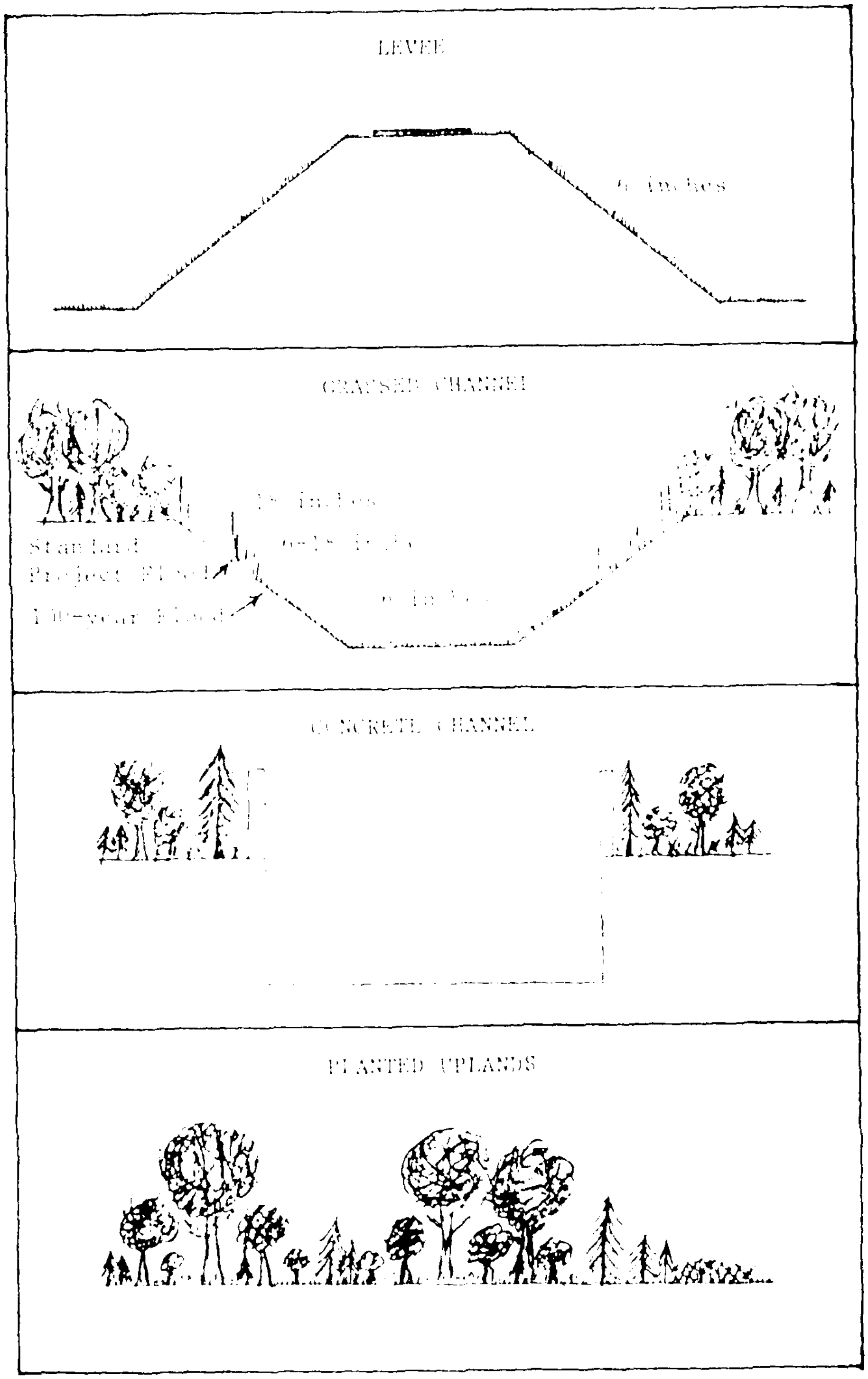
The proposed levee offers little opportunity for habitat improvement with future maintenance practices such as mowing and the use of herbicides, and planting constraints. However, the team recommends the levee be seeded with legumes and grasses following construction. Levee maintenance practices should be avoided or minimized to improve levee habitat for wildlife use.

Given these management recommendations, Figure 3 shows the habitat unit value for levee habitat over the project life of 100 years.

Channel (HUV 54 grassed, HUV 11 concrete)

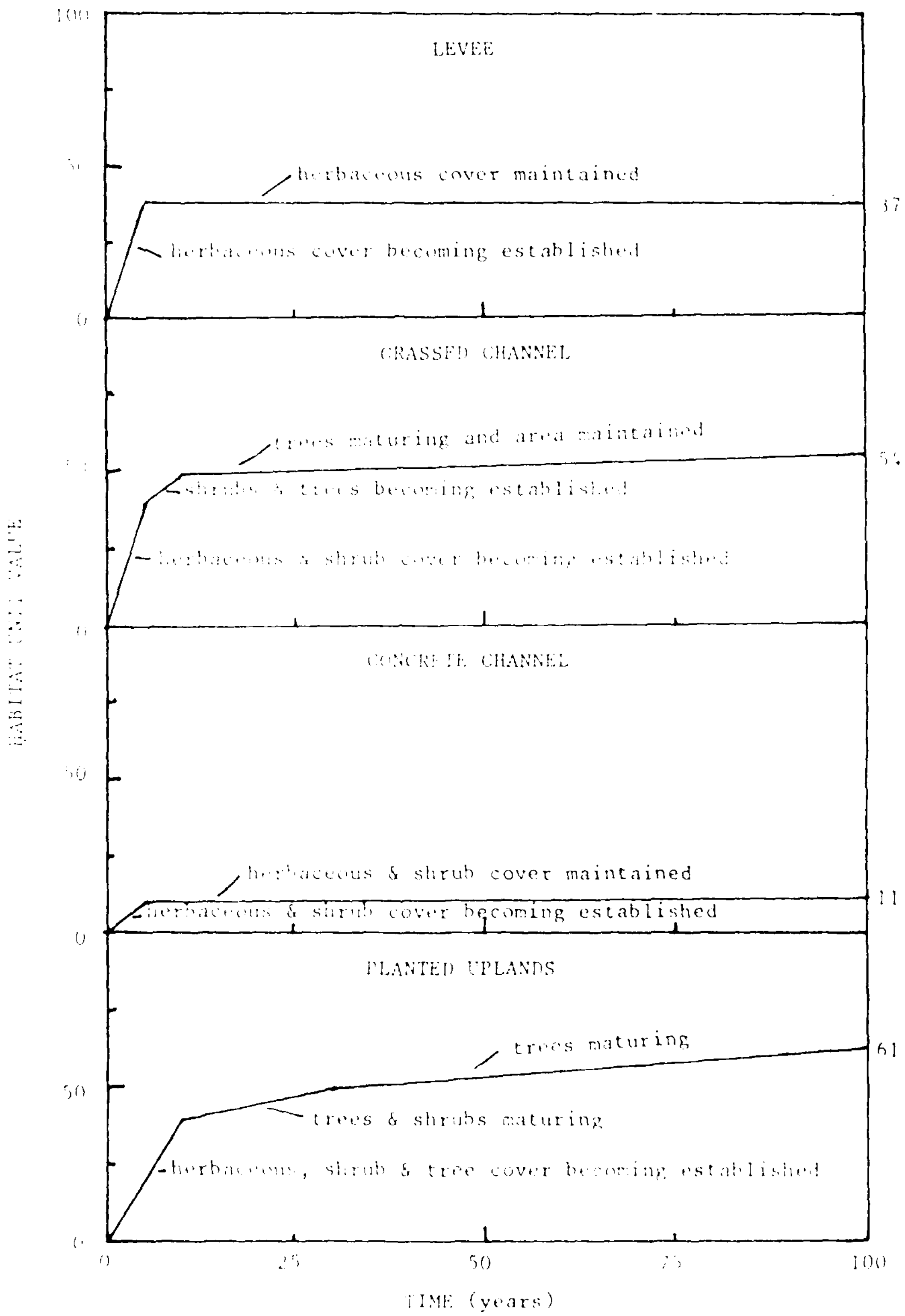
A [illegible] channel is proposed for the majority of the East Creek diversion channel. There are several opportunities for habitat improvement along the waterway. Given constraints with respect to maintenance of the structure, the team developed the following recommendations:

Figure 2. Illustration of habitat improvement measures for the Chaska Flood Control Project. Numbers shown for the levee and channel are the minimum recommended heights for maintaining vegetation.



Drawings Not To Scale

Figure 3. Habitat value of project lands for the Chaska Flood Control Project. Maximum habitat unit values for project lands were obtained from ratings shown in Table 1.


LEVEE
herbaceous cover maintained
herbaceous cover becoming established
37
GRASSED CHANNEL
trees maturing and area maintained
shrubs & trees becoming established
herbaceous & shrub cover becoming established
CONCRETE CHANNEL
herbaceous & shrub cover maintained
herbaceous & shrub cover becoming established
11
PLANTED UPLANDS
trees maturing
trees & shrubs maturing
herbaceous, shrub & tree cover becoming established
61
HABITAT UNIT VALUE
100
50
0
25
75
TIME (years)

(1) Areas within the channel proper should be seeded with grasses and legumes. Vegetation should be allowed to grow to the maximum height allowable under maintenance constraints (Figure 2).

(2) Shrubs such as willow and dogwood should be planted along the top of the channel banks. A variety of native tree species such as wild plum, choke cherry, cottonwood and maple should be planted in areas consistent with channel maintenance constraints. Plantings of small conifers are also recommended to provide winter cover.

(3) Mowing and application of herbicides for channel maintenance purposes should be avoided or minimized to improve channel habitat for wildlife use. If necessary, a barbwire fence should be installed along the outer edge of the right-of-way to protect the habitat from grazing or other agricultural disturbances.

With the adoption of the above management recommendations, Figure 3 displays the Habitat Unit Value for grassed channel habitat.

The proposed design of the concrete and riprap channel for Chaska Creek offers little opportunity for habitat improvement. However, the team recommends plantings of native shrubs and small conifers along the channel banks to improve wildlife use and provide winter cover. Given these improvements, Figure 5 displays the Habitat Unit Value for concrete channel habitat.

Planted Uplands (HUV 61)

Two areas along Chaska Creek totaling 12.2 acres also offer the opportunity

to improve project lands for wildlife use (Figure 1). With the exception of the outlet to the Chaska Creek channel, there are no constraints placed on management recommendations since these lands require no maintenance from a structural standpoint. For planted uplands, the following habitat improvement measures are recommended:

(1) Shrubs and shrubby tree species such as dogwood, hazel and Russian olive should be planted in these areas. A variety of native tree species such as oak, wild plum, choke cherry, maple and ash should also be planted. Plantings of small conifers are recommended to provide winter cover.

(2) In the outlet to the Chaska Creek channel, suitable herbaceous and shrubby vegetation should be planted within channel maintenance constraints.

(3) The above areas should be maintained and managed for wildlife purposes. If necessary, fencing should be used to restrict uses not consistent with wildlife management purposes.

With the incorporation of the above recommendations, Figure 3 displays the Habitat Unit Value for planted uplands over the project life.

SECTION V

Quantification of Project Impacts

V. Quantification of Project Impacts

Resource Categories

The FWS mitigation policy of January 23, 1981 was used for guidance in quantifying project impacts. Habitat types were placed into Resource Categories as per the policy (Table 2). No habitats were considered to fall within Resource Category 1. Lowland hardwoods were placed in Resource Category 2. Although lowland hardwoods received a lower habitat unit value (57) than some other habitats, lowland hardwoods constitute valuable wildlife habitat which is relatively scarce along the Minnesota River. Lowland hardwoods also provide a valuable corridor for wildlife uses along the river and act as an important buffer zone between agricultural/ residential areas and the aesthetic values of the river. On a national scale, lowland hardwoods are becoming increasingly scarce as their conversion to agricultural uses continues.

Category 3 habitats generally have high to medium habitat values for evaluation species. All are relatively abundant on a regional and national scale in comparison to lowland hardwoods.

Resource Category 4 habitats are generally of minimal value to wildlife (cropland, grassland). On an annual basis, wildlife use of cropland areas is limited since the crops are removed for human use. Winter cover is usually absent due to fall plowing.

In addition to existing habitats, habitats to be created by the Chaska project (levee, grassed and concrete channels, planted uplands) were

Table 2. Resource categories for project lands based on the U.S. Fish and Wildlife Service Mitigation Policy

Resource Category	Designation Criteria	Project Habitats	Mitigation Goal
1	Habitat to be impacted is of high value for evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section	None	No Loss of Existing Habitat Value
2	Habitat to be impacted is of high value for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section	Lowland Hardwoods	No Net Loss of In-Kind Habitat Value
3	Habitat to be impacted is of high to medium value for evaluation species and is relatively abundant on a national basis	Old Field, Floodplain Wetland, Isolated Riparian, West Creek Riparian, Grassed Channels, Planted [illegible]	No Net Loss of Habitat Value While Minimizing Loss of In-Kind Habitat Val
4	Habitat to be impacted is of medium to low value for evaluation species	Cropland, Pastureland, [illegible]	Minimize Loss of Habitat Value

a/ Habitats created by the Chaska Flood Control Project

also placed into resource categories (Table 2). Grassed channel and planted upland areas will provide suitable wildlife habitat provided the recommended management proposals are adopted. These habitats were placed in Resource Category 3. Concrete channel and levee habitats are of limited value to wildlife and offer little opportunity for habitat improvement. Consequently, levee and concrete channel habitats were placed in Resource Category 4.

Future Without Project

Future-without-project conditions were treated as existing conditions. In evaluating future-without-project conditions for habitats evaluated, the team used future land use information supplied by the City of Chaska and economic data obtained from the project economist (Appendix 10, Phase 1, General Design Memorandum). After reviewing the existing information on future land use in the Chaska area, the team decided to treat future-without-project conditions for most habitats as existing conditions. In general, habitats in the project area are protected and regulated through existing floodplain regulations, jurisdiction by the Corps of Engineers under the Clean Water Act, City ownership as open spaces and federal ownership within the Minnesota Valley National Wildlife Refuge. Exceptions are cropland and grassland areas outside the 100-year floodplain of the Minnesota River. Some industrial and residential developments are planned in these areas. However, as will be discussed in Section VI, project-related losses to cropland and grassland habitats do not require compensation, making intensive efforts to determine future-without-project conditions for these areas meaningless.

Consequently, the future-without-project habitat unit values and acreages are those which the team developed for the existing conditions (Table 3). The only exception is a small area on the Minnesota Valley National

Table 4. Future with and without project conditions for habitats evaluated in the Chaska study area.

Resource Category	Habitat Type	Future Without Project		Future With Project							
				Acres Lost				Annualized Habitat Units Lost			
		Acres	HUV	E. Creek	C. Creek	Levee	Total	E. Creek	C. Creek	Levee	Total
[illegible]	Old Field	48.4	81	---	---	-2.3	-2.3	---	-90.5 1/	-205.9 1/	-296.4
[illegible]	F.Wetland	3.5	74	---	---	-3.5	-3.5	---	---	-257.7	-257.7
[illegible]	I.Riparian	6.6	73	---	-6.6	---	-6.6	---	-479.4	---	-479.4
[illegible]	L.Hardwoods	251.8	57	-6.0	-1.7	-10.0	-17.7	-338.8	-175.5 1/	-583.8 1/	-1098.1
[illegible]	C.Ck.Ripar.	[illegible]	36	---	-2.0	---	-2.0	---	-70.6	---	-70.6
[illegible]	Grassland	20.[illegible]	33	-2.8	---	-16.3	-19.1	-91.9	---	-535.2	-627.1
[illegible]	Cropland	86.[illegible]	29	-7.7	-2.5 1/	-1.0 2/	-11.2	-222.2	--- 1/	-11.6	-233.8
							-62.4				-3063.1

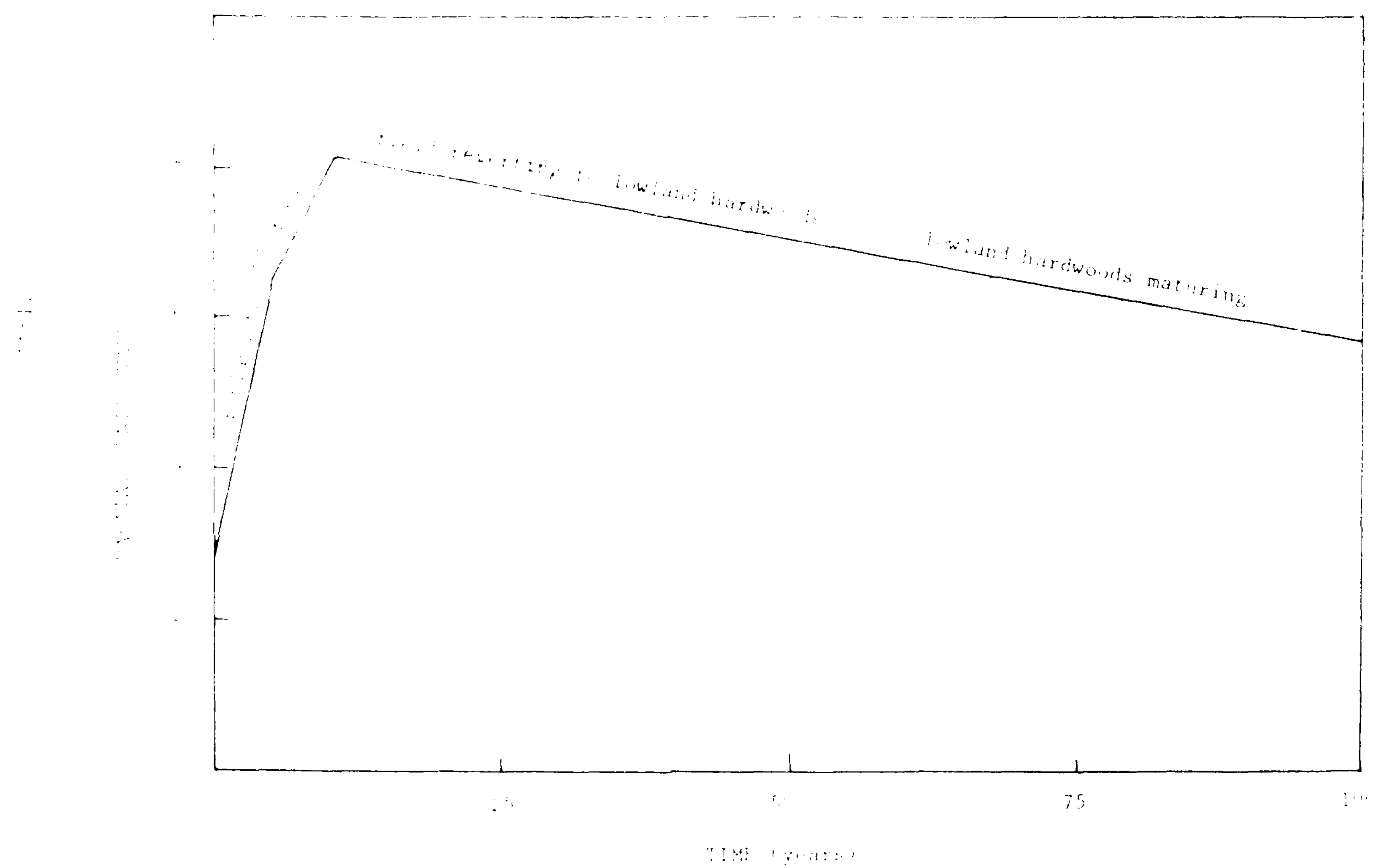
1/ The cropland area on the Minnesota Valley National Wildlife Refuge is presently old field habitat reverting to lowland hardwoods. Habitat units lost from the Chaska Creek diversion channel and levee were determined to be [illegible] old field and lowland hardwoods over the project life. Refer to Section V of text.

2/ [illegible] of this habitat is part of the cropland area discussed in 1/.

Wildlife Refuge which was a soybean field when first evaluated by the HEP team in 1979 (Figure 1). The area is now beginning to revert to old field habitat. Per refuge plans, this area would eventually become lowland hardwoods in the absence of the Chaska Flood Control Project. The proposed Chaska Creek diversion channel and levee will take approximately 3.1 acres of this area. The evaluation team decided that habitat losses to this area should not be considered as losses to cropland but should be assessed as losses to old field and lowland hardwoods over the project life.

The team assumed that the area would resemble old field habitat between years 0 and 50 and would gradually revert to its original habitat type of lowland hardwoods over the remaining 50-year period (Figure 4). Although the evaluation team recognized that natural habitat succession would not be as definitive as illustrated, this arbitrary time sequence was chosen to simplify the calculation of habitat losses. Based on the habitat values assigned by the team over the project life and the acreage involved, total annualized losses of habitat units to old field and lowland hardwoods from this former cropland area are 112.[illegible] HU and 98.6 HU, respectively. These values were added to other losses of these habitats in Table 3, Section V.

With the exception of old field habitat, remaining habitats are either at a climax stage or are actively maintained by man (e.g., cropland, grassland). Consequently, no significant change in the character of the existing habitats is anticipated over the next 100 years in the absence of the project. For the large old field habitat near Courthouse Lake, it is difficult to accurately predict future habitat changes. Much of the area is within the 100-year floodplain of the Minnesota River and therefore regulated from most commercial residential development.


lowland hardwoods maturing
75
TIME (years)

In view of the existing uses of adjacent lands, the team felt it unlikely that the area would be allowed to revert to lowland hardwoods. Consequently, the team assumed the area would remain as old field habitat in the absence of the project.

Future With Project

Future-with-project conditions are presented in Table 3. Overall, the proposed Chaska Flood Control Project will result in the loss of approximately 62.4 acres and 3063.1 habitat units for habitats evaluated.

SECTION VI

Determination of Compensation

Recommendations

VI. Determination of Compensation Recommendations

In comparing future with and without project conditions (see Table 3), the team used the FWS mitigation policy for guidance. For all habitats, the team assumed that project-related losses would be minimized to the greatest extent practicable by project design modifications.

Resource Category 2

This Resource Category is limited to lowland hardwoods. The mitigation goal for Resource Category 2 habitats is no net loss of in-kind habitat value (Table 2). Since lowland hardwoods will be converted to lower category habitats (i.e., Resource Category 3 or 4 habitats), all losses to lowland hardwoods were considered as total losses to be compensated (-1098.1 HU, Table 4).

Resource Category 3

The mitigation goal for Resource Category 3 habitats (Old Field, Floodplain Wetland, Isolated Riparian, Chaska Creek Riparian) is no net loss of habitat value while minimizing loss of in-kind habitat value. Two possible situations exist with respect to Resource Category 3 losses:

(1) A Category 3 habitat is converted to a different Category 3 habitat of lesser value. This situation occurred when 4.6 acres of Isolated Riparian habitat (HUV73,-334.1 HU) was converted to the same acreage of Planted Uplands (HUV61,+228.4 HU; Table 4). In this case, the net loss in habitat units (-105.7 HU) was considered as the loss to be compensated.

Table 4. Annualized habitat units lost and gained from construction of the Chaska Flood Control Project. Changes in habitat units1/ were used in determining compensation needs (Table 5) and are explained in Section VI of the text. Habitat units displayed in this table were annualized in the HEP'76 program and are not simply the product of acres and habitat unit values (HUV). HUV's for habitats gained are maximum values from implementation of the recommended habitat improvement measures in Section IV and displayed in Figure 3.

	Habitat Lost					Habitat Gained					
	Habitat Type	Resource Category	Acres	HUV	Habitat Units	Habitat Type	Resource Category	Acres	HUV	Habitat Units	Change in Habitat Units
E. CREEK	Lowland Hwds.	2	-6.0	57	-338.8	G. Channel	3	+6.0	54	+299.1	[illegible]
	Grassland	4	-2.8	33	-91.9	G. Channel	3	+2.8	54	+139.6	[illegible]
	Cropland	4	-7.7	29	-222.2	G. Channel	3	+7.7	54	+383.8	[illegible]
C. CREEK	I. Riparian	3	-4.6	73	-334.1	P. Uplands	3	+4.6	61	+228.4	[illegible]
	I. Riparian	3	-2.0	73	-145.3	C. Channel	4	+2.0	11	+21.3	[illegible]
	Lowland Hwds.	2	-1.7	57	-96.0	P. Uplands	3	+1.7	61	+84.4	[illegible]
	C. Cr. Riparian	3	-1.4	36	-49.4	P. Uplands	3	+1.4	61	+69.5	+20.1
	C. Cr. Riparian	3	-0.6	36	-21.2	C. Channel	4	+0.6	11	+6.4	-21.2
	Old Field2/	3	-1.25	81	-90.5	C. Channel	4	+1.25	11	+13.3	-90.5
	Lowland Hwds.2/	2	-1.25	57	-79.5	C. Channel	4	+1.25	11	+13.3	-79.5
LEVEE	Old Field	3	-2.3	81	-184.2	Levee	4	+2.3	37	+82.6	-184.2
	F. Wetland	3	-3.5	74	-257.7	Levee	4	+3.5	37	+125.6	-257.7
	Lowland Hwds.	2	-6.1	57	-344.5	Levee	4	+6.1	37	+218.9	-344.5
	Grassland	4	-16.3	33	-535.2	Levee	4	+16.3	37	+585.0	[illegible]
	Cropland	4	-0.4	29	-11.6	Levee	4	+0.4	37	+14.4	[illegible]
	Lowland Hwds.	2	-3.9	57	-220.2	P. Uplands	3	+3.9	61	+193.6	[illegible]
	Old Field2/	3	-0.3	81	-21.7	P. Uplands	3	+0.3	61	+14.9	[illegible]
	Lowland Hwds.2/	2	-0.3	57	-19.1	P. Uplands	3	+0.3	61	+14.9	[illegible]

2/ This portion of the Minnesota Valley National Wildlife Refuge is presently old field habitat reverting to lowland hardwoods. Habitat units lost from the Chaska Creek diversion channel and levee were determined to be losses to old field and lowland hardwoods over the project life. Refer to Section V of text.

(2) A Resource Category 3 habitat is converted to a Category 4 habitat. For example, 2.0 acres of Isolated Riparian habitat (HUV73,-145.3 HU) was converted to the same acreage of concrete channel (HUV11,+21.3 HU Table 4). In these cases, losses to Resource Category 3 habitats were considered as total losses (i.e., -145.3 HU for the above example). Resource Category 4 habitats are of marginal value to wildlife. Since compensation is not required for losses to Category 4 habitats, per the mitigation policy, it would be inconsistent to factor in their habitat value to offset losses to Category 3 habitats. Total losses under these situations were 705.7 HU. Total losses to all Resource Category 3 habitats was 811.4 HU.

In one instance, a Resource Category 3 habitat was converted to a Category 3 habitat having a higher habitat value. This occurred when 1.4 acres of Chaska Creek Riparian habitat (HUV36,-49.4 HU) was converted to the same acreage of Planted Uplands (HUV61,+69.5 HU, Table 4). In this case, the net gain of 20.1 habitat units was used to offset losses to Category 3 habitats.

Resource Category 4

The mitigation goal for Resource Category 4 habitats (cropland, grassland) is to minimize project-related impacts. Consequently, compensation for unavoidable losses to these habitats is not required. It may be considered appropriate to ignore these habitats throughout the remainder of the analysis since compensation is not required for project impacts. However, an objective of the team was to develop habitat improvement measures to improve project lands for wildlife use and consequently reduce compensation needs. Therefore, in order to credit habitat improvement proposals recommended by the team for the levee and channels

traversing Resource Category 4 habitats, the team used habitat gains resulting from the conversion of grassland or cropland habitats to habitats having a higher value (grassed channel, levee, planted uplands) to offset losses to Category 3 habitats. Gains were determined by taking the net difference between the existing habitat value and the improved habitat value through management. For example, 7.7 acres of Cropland habitat (HUV29,-222.2 HU) was converted to the same acreage of grassed channel (HUV54+383.8 HU) having a higher habitat value due to habitat improvement measures (Table 4). In this case, the net gain of 161.6 habitat units was applied to offset losses. Total habitat units applied to offset Resource Category 3 losses was 261.9 HU (Table 4).

In summary, total losses to Resource Category 2 and 3 habitats were 1098.1 HU and 811.4 HU, respectively (Table 5). Total gains from management proposals used to offset losses to non-wetland Category 3 habitats was 282.0 HU. Total losses to be compensated are 1627.5 HU. It should be noted that habitat gains applied to offset losses are due, for the most part, to habitat improvement recommendations for project lands as described in Section IV. If these recommendations are not adopted by the Corps of Engineers as an integral part of the Chaska project, total losses to be compensated will be in excess of 1627.5 HU.

Table 5. Summary of compensation needs for the Chaska Flood Control Project. Habitat units gained were applied to offset losses to Resource Category 3 habitats. Compensation is needed to replace a total loss of 1627.5 habitat units (refer to Section VI of text and Table 4).

Resource Category	Habitat Units Lost	Habitat Units Gained
2	-1098.1	0
3	-811.4	+20.1
4	1/	+261.9

1/ USFWS mitigation policy does not require compensation for losses to Resource Category 4 habitats.

SECTION VII

Compensation Recommendations

VII. Compensation Recommendations

Introduction

Up to this point, the evaluation team has recommended measures to avoid and minimize adverse impacts to selected habitats, has recommended measures to improve project lands for wildlife purposes, has quantified project-related impacts to selected habitats, and has quantified unavoidable habitat losses to be compensated. The remainder of the analysis will deal with the development of compensation proposals to replace habitat losses to wildlife resources from construction of the Chaska Flood Control Project.

The U.S. Fish and Wildlife Service (FWS) mitigation policy was used for guidance in developing compensation proposals. The first priority of the team was to attempt to replace habitat units lost from the Chaska project (1627.5 HU) by developing compensation proposals involving habitat management and improvement of existing public lands in lieu of requesting additional land aquisition. The team selected the Minnesota Valley National Wildlife Refuge as the land base for possible compensation projects. Other public lands near Chaska such as City or State holdings were either too small, were not in the vicinity of Chaska, or had land uses which would conflict with wildlife management objectives. Since the refuge was established for wildlife purposes, refuge operations would be more consistent with the team's habitat improvement proposals than existing or future use of other public lands in the vicinity of Chaska.

A problem was encountered in developing compensation plans for losses

to lowland hardwoods. The habitat evaluation determined a need to replace 1098.1 habitat units for lowland hardwoods. The FWS mitigation policy is based on mitigation of habitat losses by specific resource categories (Table 2). For Resource Category 2 habitats, the mitigation goal is in-kind replacement of habitat losses <u>unless</u> different habitats and species available for replacement are determined to be of greater value than those lost, or in-kind replacement is not physically attainable in the ecoregion section.

The team attempted to develop several proposals for in-kind replacement of losses to lowland hardwoods -- the only Resource Category 2 habitat in the study -- by management of existing lowland hardwoods, or reconversion of former lowland hardwoods (cropland). After several field reviews, it was determined that these alternatives were not practical. Existing lowland hardwoods along the Minnesota River are already valuable wildlife habitat. This habitat is strongly influenced by frequent river flooding which substantially limits the development of long term habitat improvement measures such as plantings or selective cuttings. The value of management measures suggested would likely be reduced by frequent flooding.

Allowing cropland areas to revert to lowland hardwoods was also determined to be inappropriate. Existing cropland areas could be managed as shallow marsh or food plots which the team felt would provide greater wildlife benefits per acre over time than allowing these areas to revert to lowland hardwoods.

Consequently, compensation proposals developed by the team involve out-of-kind habitat replacement of losses to lowland hardwoods. Although regretable, the team felt this situation was consistent with the mitigation policy, as per the exception clause, for losses to Resource Category

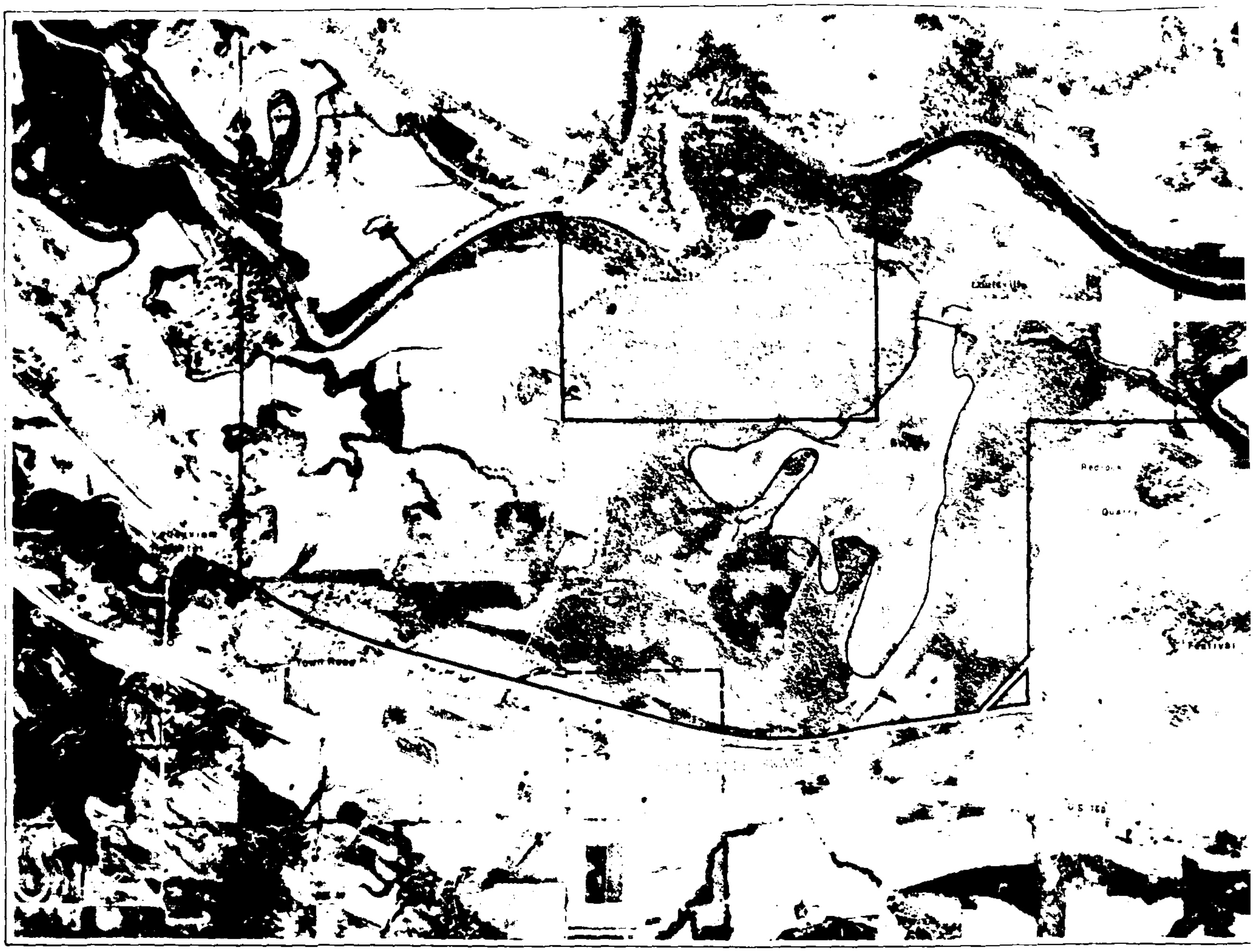
2 habitats. For losses to Resource Category 3 habitats, out-of-kind replacement for project losses is appropriate provided there is no loss of total habitat value. Although out-of-kind habitat replacement is recommended, it should be noted that compensation proposals would result in in-kind replacement for losses to non-consumptive wildlife uses. On a species basis, compensation for habitat losses to evaluation species would also generally be in-kind for the same species, with some exceptions.

Methods

In consultation with refuge personnel, several possible compensation projects were identified on the Minnesota Valley National Wildlife Refuge (Figure 5). These projects involve the construction of three water control structures, a moist soil management unit, and an impoundment. Due to their location in wetland or floodplain areas, construction of these projects may require the approval of various state and local units of government. Chaska Lake is presently designated by the Minnesota Department of Natural Resources as a protected water of the state. The proposed water control structure would require a permit from the Minnesota Department of Natural Resources. In addition, Chaska Lake and adjacent wetlands are also under the authority of Section 404 of the Clean Water Act. To determine the effects of a change in existing water levels, detailed studies may be necessary. If adverse effects would occur to private lands from operation of the water control structure, easements or agreements with the affected landowners may be required. These projects may also require the approval from the Minnesota Department of Natural Resources and Lower Minnesota River Watershed District for development in floodplain areas.

The habitat evaluation methodology presented in Section II was used to evaluate each project. The existing habitat unit value at each site

Figure 5. Location of compensation projects evaluated for the Chaska Flood Control Project. Compensation sites are located on the Minnesota Valley National Wildlife Refuge.



MINNESOTA VALLEY

NATIONAL WILDLIFE REFUGE

U.S. FISH AND WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

CHASKA LAKE and LOUIS...

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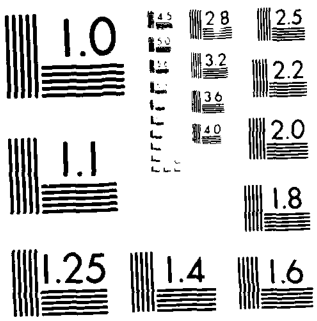

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Table 6. Acreage, habitat unit values (HUV), management potential, and annualized gain in habitat units for compensation projects on the Minnesota Valley National Wildlife Refuge.

Project	Acres	Existing HUV	Management Potential[1/]	HUV With Mgmt.	Total Habitat Units Gained
Moist Soil Unit	19	29	40	69	760
Impoundment	17	29	40	69	680
Water Control Structure					
Chaska Lake	57	58	18	76	1026
Type III Wetland	80	79	10	89	800
Louisville Swamp	200	73	10	83	2000

[1/] Habitat units gained through management/acre/year.

was determined based on selected evaluation species (Table 1). Evaluation species were selected to represent an ecological cross section of the faunal community and were generally an appropriate mixture of species used to evaluate project habitats. The team then estimated the management potential for each site -- how much the existing habitat unit value could be improved through management over the project life (Table 6). The management potential was based on the professional judgememt of team members in consultation with biologists at the Minnesota Valley National Wildlife Refuge. In general, areas with a low existing habitat value, such as cropland, can be improved for wildlife purposes to a greater degree on a per acre basis than areas having a high existing habitat value such as wetlands. The annualized management potential (habitat units gained through management/acre/year) was multiplied by the acreage available at each project site to obtain the total gain in habitat units for each project (Table 6). These habitat gains were used by the team in developing the following three alternative compensation proposals for the Chaska project. Construction of a water control structure on the outlet to the Type III wetland was not included in any of the proposals since a major portion of the affected area is presently in private ownership.

Compensation Proposal A

Compensation Proposal A involves the development of a moist soil management unit and construction of a water control structure. Both projects are located immediately south of Chaska on the Chaska Lake Unit, a recent addition to the Minnesota Valley National Wildlife Refuge (Figure 5). Total annualized gain in habitat units from construction, operation and maintenance of these projects is 1786 HU (Table 6).

Presently, the Chaska Lake Unit is a mixture of public and private ownership (Figure 5). Due to current and foreseeable fiscal limitations, it may be several years before FWS can complete the refuge acquisition. Although this presents management problems for refuge personnel, the team does

not anticipate significant problems in realizing habitat gains from these projects due to a lack of complete refuge ownership.

Description of Chaska Lake Unit

Information on the Chaska Lake Unit of the Minnesota Valley National Wildlife Refuge was provided by refuge personnel. Chaska Lake and its adjacent marshes are the dominant features of this unit. The unit was purchased in 1978 and has received little active management effort. The primary purpose of the Chaska Lake Unit is for use as a wildlife refuge and for wildlife interpretation. Waterfowl use of Chaska Lake is high due to the abundance of aquatic vegetation. The adjacent wetlands are spring fed, contain an abundance of aquatic vegetation and support a high density of furbearers and waterfowl.

Chaska Lake supports a fishery typical of many Minnesota game lakes. Species present include northern pike, yellow perch, crappie, bluegill, carp and bullheads. Winterkill of these species does not appear to be a significant problem probably because of the inflow of spring water.

Existing agricultural use in the Chaska Lake Unit will be modified to allow the creation of an agricultural demonstration plot, wildlife food plots and maintained grasslands. The recommended moist soil management unit will utilize 19 acres of existing cropland. There are no grasslands presently on the unit. The forests are composed primarily of lowland hardwoods vegetated with ash, silver maple, elm and cottonwood. Frequently flooded areas have dense stands of silver maple. Understory vegetation is sparse due to the dense overstory. Ground cover is generally leaf litter and plant debris with heavy growth of nettle.

The location of the Chaska Lake Unit is ideal for wildlife interpretation. Wildlife interpretation is a refuge purpose for this unit and a trail system has been proposed by the Fish and Wildlife Service. It is anticipated that this unit will receive substantial use by the residents of

nearby Chaska and vicinity. Public use will be primarily non-consumptive since, with the exception of private inholdings, the unit is closed to hunting and trapping.

Moist Soil Management Unit

As part of Compensation Proposal A, the team recommends construction of a 19-acre moist soil management unit. The completed project would resemble a shallow wetland which would provide valuable feeding habitat for songbirds, wading birds and waterfowl. Of the five compensation projects evaluated, this project and the adjacent impoundment had the highest management potential (40 HU/acre/year). In addition to providing valuable wildlife habitat, development of this area should be of particular interest to birdwatchers.

The 19-acre unit would be located on an existing cropland area adjacent to and east of Chaska Lake (Figure 5). The moist soil unit is divided into upper and lower subunits which can be managed independently. A preliminary layout of the moist soil management unit is shown in Appendix B. Upon completion of the dike system, the enclosed unit would be disked in the spring to encourage desirable plant species. After the plants become established, the unit would be flooded either by pumping water from Chaska Lake, or the Minnesota River. Dike slopes would be planted with suitable grasses to provide additional wildlife habitat.

Chaska Lake Water Control Structure

In addition to the moist soil management unit, the team also recommends construction of a water control structure on the Chaska Lake outlet (Figure 4). Although Chaska Lake is presently one of the most productive waterfowl areas on the refuge, the addition of a water control structure will enable wildlife managers to manipulate water levels for

Table 7, Estimated costs for compensation projects on the Minnesota Valley National Wildlife Refuge.

Project	Estimated Cost [1/]
Moist Soil Unit	$132,000-188,000 [2/]
Impoundment	98,000-224,000 [2/]
Water Control Structure	
Chaska Lake	30,000-40,000
Type III Wetland	30,000-40,000
Louisville Swamp	105,000-155,000 [3/]

[1/] Costs are preliminary and subject to change due to a lack of detailed studies. Detailed studies would likely reduce costs.

[2/] Refer to Appendix B for more detailed information.

[3/] Approximately 1500 feet of road rehabilitation & dike construction @$50.00/foot plus construction of water control structure(s) @$30,000-40,000 each.

various desired management objectives such as to enhance the growth of submerged aquatic vegetation or to provide the optimum ratio of emergent vegetation to open water.

Project Implementation

At present, there have been no detailed studies conducted for either of the recommended projects. Estimated costs for these projects are shown in Table 7. Estimates are expected to be reduced with additional engineering feasibility studies. The team recommends that design and construction of the moist soil management unit and Chaska Lake water control structure, and purchase of any equipment necessary to operate these facilities such as pumps, be incorporated as project features of the selected alternative. Likewise, the U.S. Fish and Wildlife Service should assume operation and maintenance responsibilities and expenses. The facilities should be operated by refuge personnel for maximum wildlife benefits. Any interpretive materials developed by the Corps of Engineers, Fish and Wildlife Service or City of Chaska, such as signing or informational leaflets, should acknowledge that these projects were jointly developed by the Corps of Engineers, City of Chaska, and the Fish and Wildlife Service in cooperation with the Minnesota Department of Natural Resources as part of the overall Chaska Flood Control Project.

Compensation Proposal B

Compensation Proposal B involves the development of the moist soil management unit recommended in Proposal A and an impoundment. Both projects are located on the Chaska Lake Unit of the Minnesota Valley National Wildlife Refuge which is described in Proposal A. Total annualized gain in habitat units from construction, operation and maintenance of these projects is 1440 HU (Table 6). This proposal is recommended by

the evaluation team as compensation for the Chaska project even though it does not entirely replace the loss of 1627.5 habitat units. The team decided that overall wildlife benefits resulting from development of this proposal outweigh the net difference of 187.5 habitat units.

Impoundment

In addition to the moist soil unit, Proposal B also involves construction of a 17-acre shallow impoundment. The impoundment would be located on an existing cropland area immediately south of the recommended moist soil management unit (Figure 5). A preliminary layout of Proposal B is shown in Appendix B. Construction methods and expected habitat benefits would be similar to the moist soil unit described in Proposal A.

Project Implementation

At present, there have been no detailed studies conducted for either of the recommended projects. Estimated costs for these projects are shown in Table 7. Cost estimates are expected to be reduced with additional engineering feasibility studies. The team recommends that design and construction of the moist soil management unit and impoundment, and purchase of any equipment necessary to operate these facilities such as pumps, be incorporated as project features of the selected alternative. Likewise, the U.S. Fish and Wildlife Service should assume operation and maintenance responsibilities and expenses. The facilities should be operated by refuge personnel for maximum wildlife benefits. Any interpretive materials developed by the Corps of Engineers, Fish and Wildlife Service or City of Chaska, such as signing or informational leaflets, should acknowledge that these projects were jointly developed by the Corps of Engineers, City of Chaska, and the Fish and Wildlife Service in cooperation with the Minnesota Department of Natural Resources as part of the overall Chaska Flood Control Project.

Compensation Proposal C

Compensation Proposal C developed by the evaluation team involves the rehabilitation of an existing dike/road and construction of a water control structure and spillway on the Louisville Swamp Unit of the Minnesota Valley National Wildlife Refuge located approximately 3 miles south of Chaska (Figure 5). Total annualized gain in habitat units from construction, operation and maintenance of this project is 2000 HU (Table 6).

The entire Louisville Swamp Unit is under refuge ownership and does not have the landowner problems associated with the Chaska Lake Unit. Therefore, the team does not foresee problems associated with operation of a water control structure at this location.

A problem associated with habitat management of the existing Louisville Swamp Unit is that water levels in Louisville Swamp are influenced by flooding from both Sand Creek and the Minnesota River backing up into Sand Creek. A water control structure should provide beneficial results in controlling water levels in most cases. However, it should be recognized that there will be times when both flooding mechanisms are at work simultaneously. In this event, water levels in Louisville Swamp will be dictated by flood flows.

Description of Louisville Swamp Unit

Information regarding the Louisville Swamp Unit of the Minnesota Valley National Wildlife Refuge was provided by refuge personnel. Like the Chaska Lake Unit, the primary purpose of the Louisville Swamp Unit is as a refuge for wildlife. The Louisville Swamp Unit is one of the most diverse units of the refuge. A variety of habitats are found on the unit including oak savannah, prairie, wet meadow, cropland, floodplain and upland forests.

The dominant feature of the unit is Louisville Swamp, a large wetland complex adjacent to Sand Creek, a tributary to the Minnesota River. Water levels in Louisville Swamp are influenced by flooding from Sand Creek and the Minnesota River. Water levels fluctuate widely at times which can be detrimental to wildlife resources and can hamper management efforts.

A scarce or non-existent feature on other units but present on Louisville is upland prairie and its gradation into oak savannah. Several wet meadows are also present on the unit. Forest habitat on the Louisville Swamp Unit ranges from dense, mature stands of silver maple in floodplain areas to a mixture of oak, elm and ash on higher ground.

In addition to providing valuable wildlife habitat, the Louisville Swamp Unit also receives extensive public use. Major features on the unit include the State Corridor and Maxomani Trails. These trails are maintained and are located to take advantage of the terrain and points of ecological, historic, or geological interest.

Louisville Swamp Water Control Structure

An obvious management need at Louisville Swamp is the ability to control water levels. To allow for water level management, the team recommends a water control project for this area. The project would consist of raising approximately 300 feet of existing roadbed and constructing a water control structure and spillway. Additional dike construction may also be necessary. The control structure should have the capacity to raise water levels approximately 2 feet above the existing marsh elevation.

Construction and operation of this project will allow intensive wildlife management of the Louisville Swamp through appropriate water level manipulation of Sand Creek, and will also assist in keeping floodwaters from backing into the area from the Minnesota River. In addition to

providing wildlife benefits, this project will also enhance wildlife interpretation along existing trails and provide an excellent opportunity to develop an interpretative canoe route through the area.

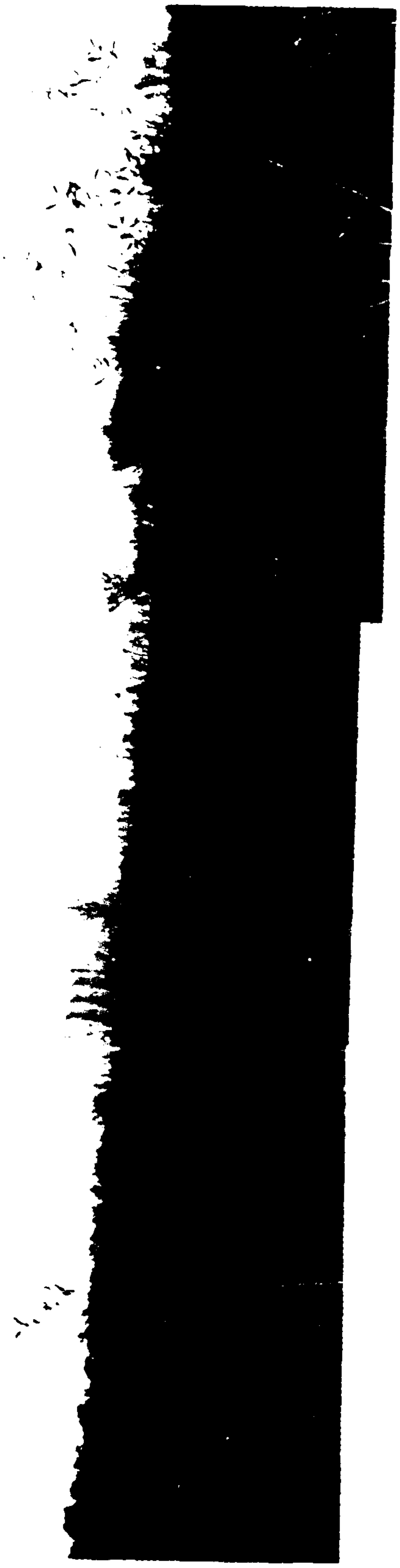
Project Implementation

As with Compensation Proposal A, there have been no detailed studies conducted for the recommended project at Louisville Swamp. Estimated costs in Table 7 are quite general since studies are needed to determine the feasibility and design of the project. The team recommends that design and construction of the Louisville Swamp Water Control Project and purchase of any equipment necessary to operate this facility be incorporated as project features of the selected plan. Likewise, the U.S. Fish and Wildlife Service should assume operation and maintenance responsibilities and expenses. The facilities should be operated by refuge personnel for maximum wildlife benefits. Any interpretive materials developed by the Corps of Engineers, Fish and Wildlife Service or City of Chaska, such as signing or informational leaflets, should acknowledge that this project was jointly developed by the Corps of Engineers, City of Chaska, and the Fish and Wildlife Service in cooperation with the Minnesota Department of Natural Resources as part of the overall Chaska Flood Control Project.

SECTION VIII

Appendices

Appendix A. Photographs of habitats evaluated for the Chaska Flood Control Project. Figure 1 (see page 11-18) shows the locations of the photos.



FLOODPLAIN WETLAND

4B

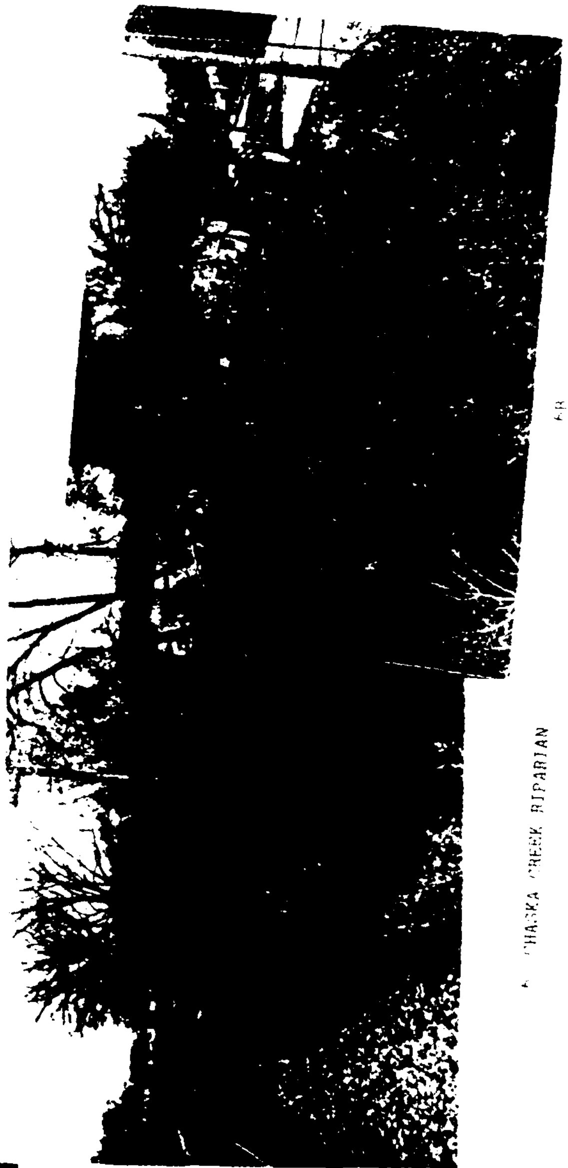
4A

4A

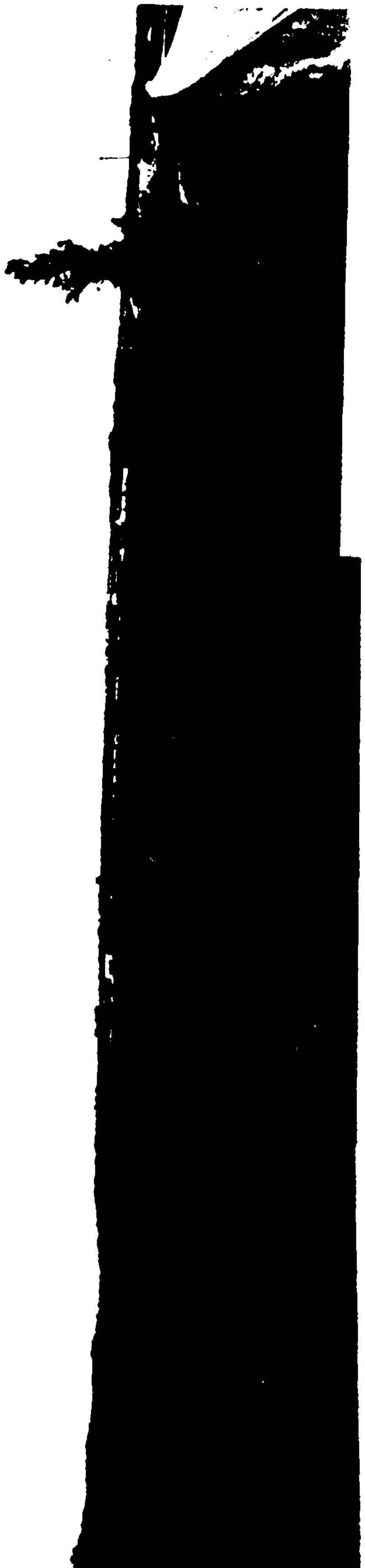
4C

LOWLAND HARDWOODS

MINNESOTA RIVER AND
ADJACENT LOWLAND HARDWOODS



A. CHASKA CREEK RIPARIAN



Appendix B. Additional information on the impoundment and moist soil management unit proposed by the evaluation team as compensation. Both projects are located on the Chaska Lake Unit of the Minnesota Valley National Wildlife Refuge. Design layouts are conceptual since no detailed studies have been conducted.

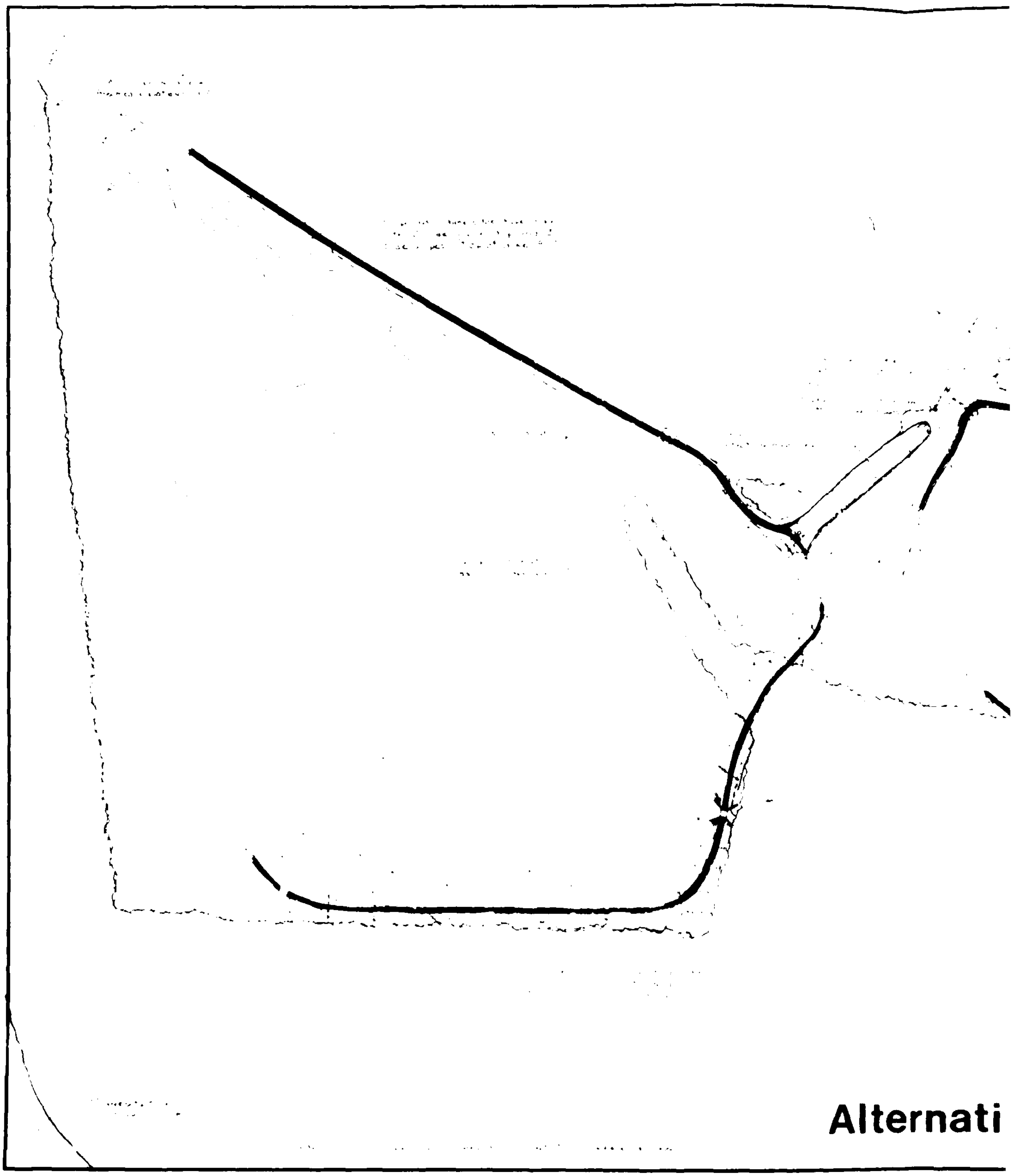
There are two possible water supplies for the impoundment and moist soil units. Alternative A proposes to pump water from Chaska Lake while Alternative B proposes to pump water from the Minnesota River. Under Alternative B, the moist soil units would either be fed by a pipe directly from the intake area (Option 1), or by a control structure and outlet ditch on the impoundment (Option 2). Estimated costs are presented in Table B1.

Alternatives A and B are depicted in figures B1 and B2, respectively.

Table B[illegible] Estimated costs for the moist soil management unit and impoundment on the Minnesota Valley National Wildlife Refuge. Refer to text of Appendix B for a description of each alternative and option.

Feature	Alternative A		Alternative B			
			Moist Soil Unit		Impoundment	
	Moist Soil Unit	Impoundment	Option 1	Option 2	Option 1	Option 2
outer dike, [illegible]	$85,000		$85,000	$85,000		
inner levee, [illegible]	11,200		11,200	11,200		
site preparation	15,000		15,000	15,000		
outlet ditch	5,000		5,000	5,000		
lake inlet structure	5,000					
lake outlet structure	3,000					
lower pool outlet structure	8,000		8,000	8,000		
inner levee structures, [illegible]	6,000		6,000	6,000		
pump platform [illegible]	25,000					
pump	25,000					
concrete pad [illegible]			2,000	2,000		
outer dike, [illegible]		$67,500			$67,500	$81,000[1]
site preparation		8,000			8,000	8,000
ditch to pump platform		5,000				
culverts [illegible]		3,000				
outlet structure		15,000				
ditch to moist soil unit						3,000
main outlet structure					15,000	18,000
structure [illegible] moist soil unit						5,000
permanent pumping station [illegible]					100,000	100,000
pipe [illegible] soil unit, [illegible] foot					34,000	
Totals	$188,200	$98,500	$132,200	$132,200	$224,500	$215,000

[1] [illegible]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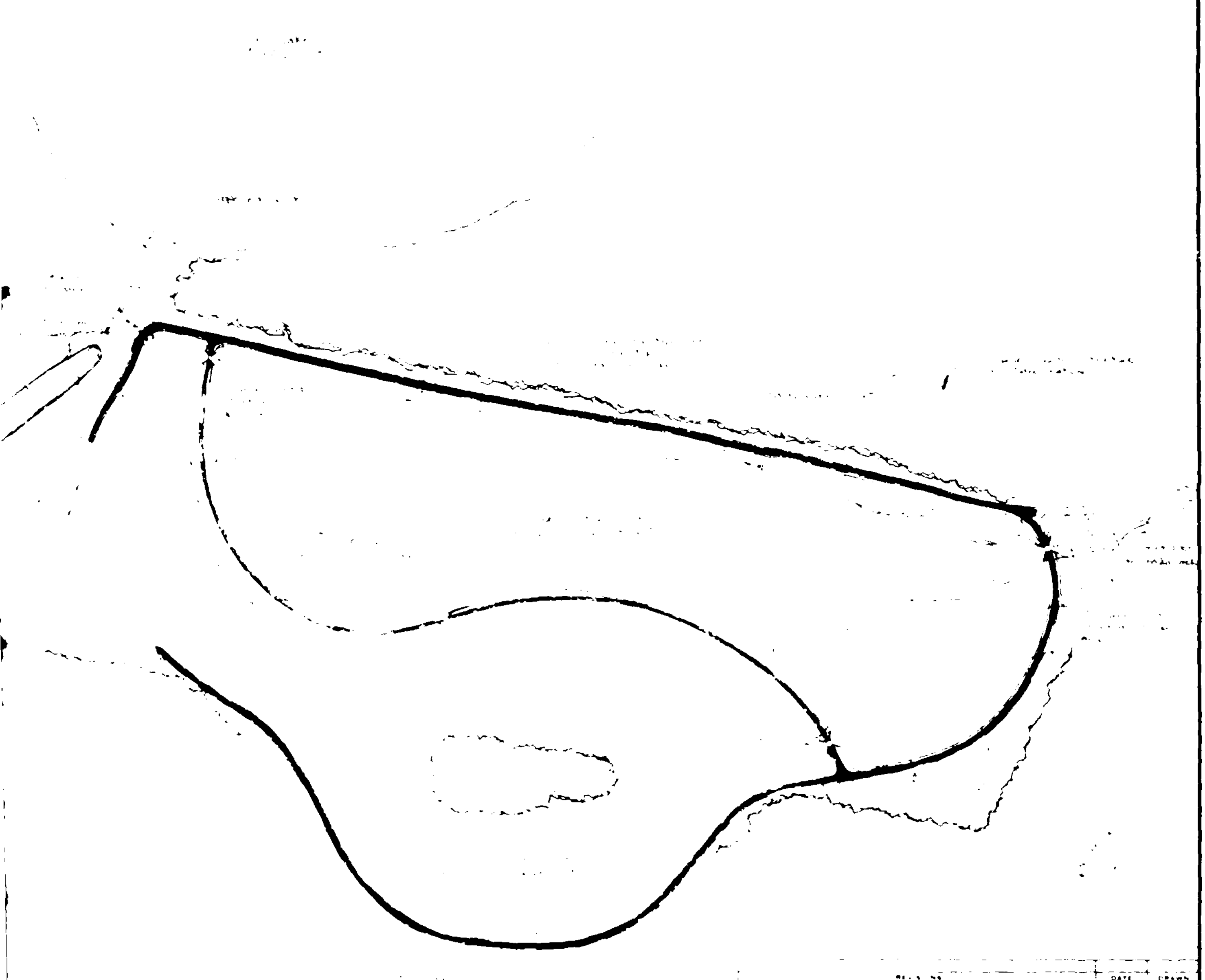

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UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

REGION 3 TWIN CITIES MINN

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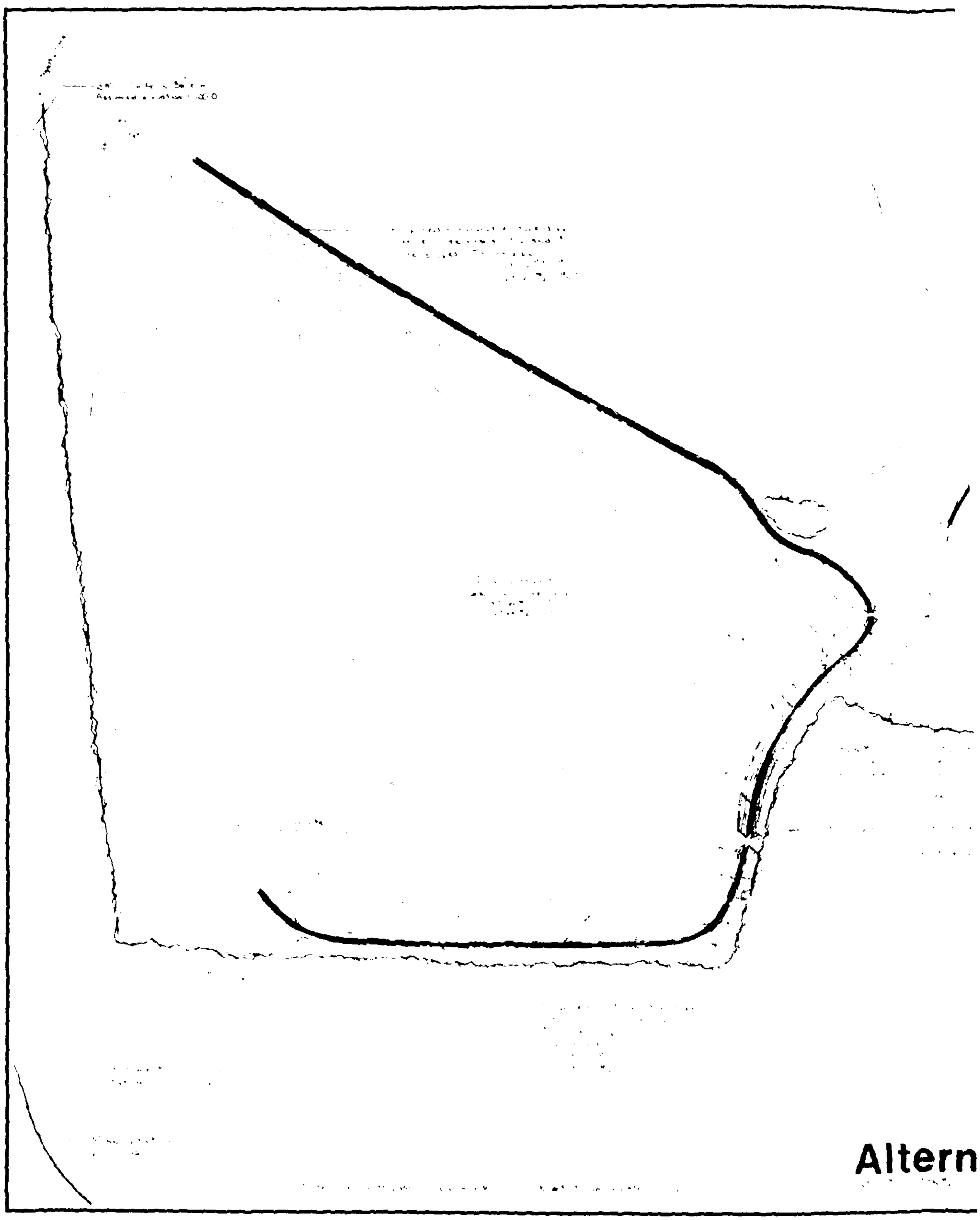
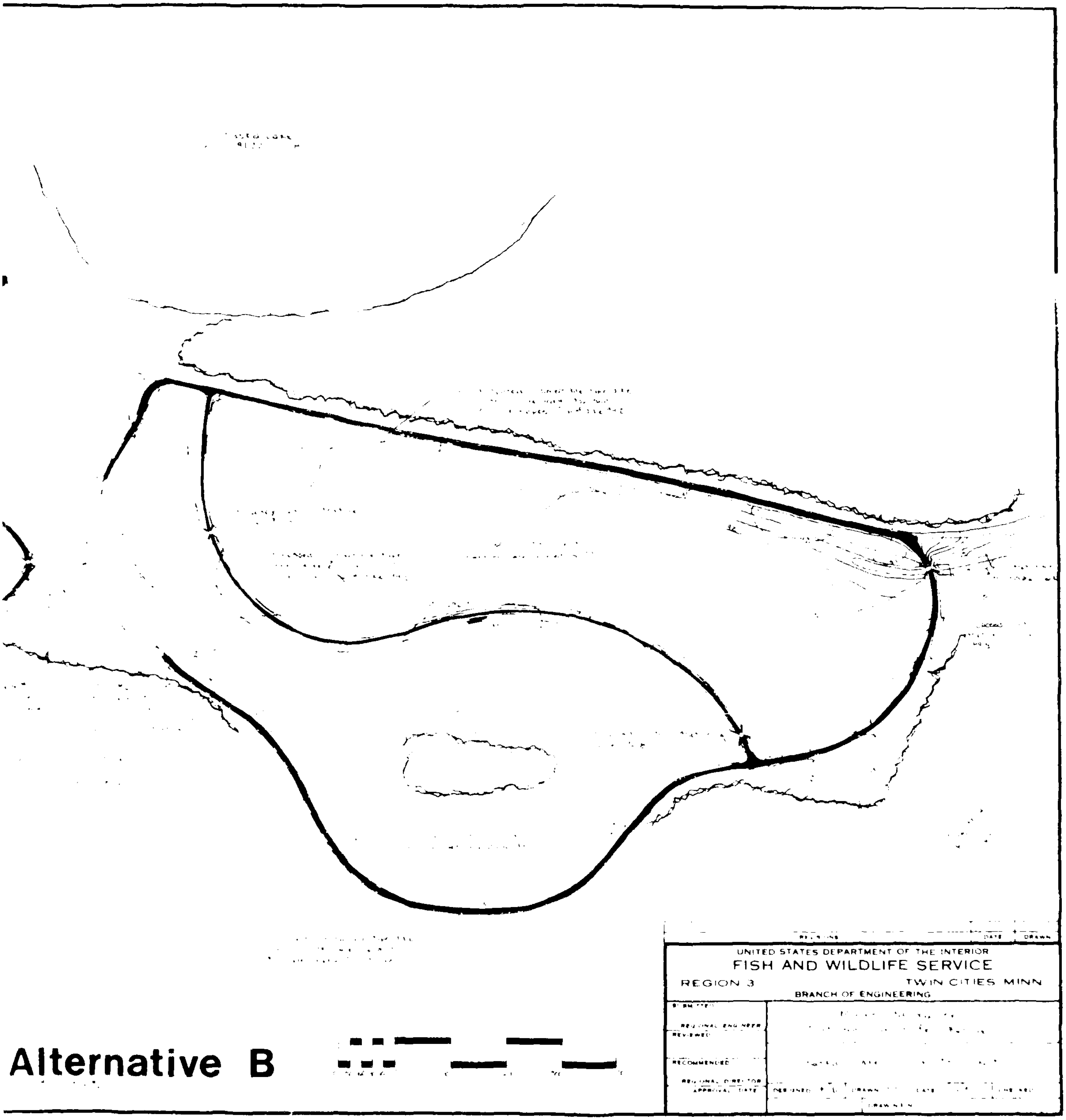
Figure B1
11-80


Altern



Alternative B

Figure B2

11-81

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Bishop Henry Whipple Federal Building
Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
AH/ES

AUG 27 1982

Colonel Edward G. Rapp
District Engineer
United States Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Rapp:

This letter constitutes the final Fish and Wildlife Coordination Act (FWCA) report for the Chaska Flood Control Project in Chaska, Carver County, Minnesota.

The Fish and Wildlife Service has been involved in this project since the early 1970's. In October 1979, a habitat evaluation was initiated for the Chaska Flood Control Project in Chaska. The evaluation was conducted by a tri-agency team of biologists representing the Minnesota Department of Natural Resources, United States Army Corps of Engineers-St. Paul District, and the United States Fish and Wildlife Service. The team's analysis was conducted in accordance with the Service's Habitat Evaluation Procedures (HEP).

On December 23, 1981, a draft FWCA report was submitted to the St. Paul District which evaluated the selected plan for flood control in Chaska. The FWCA report quantified project-related impacts to fish and wildlife resources and recommended habitat management measures to minimize and compensate for unavoidable losses to valuable wildlife habitats based on the Fish and Wildlife Service's mitigation policy.

The Fish and Wildlife Service has reviewed comments from the Corps of Engineers on the draft FWCA report. These comments are contained in the Draft Phase 1 General Design Memorandum. We concur with your recommendations and support the Chaska Flood Control Project which includes implementation of Compensation Proposal A identified in the draft FWCA report. The selected compensation plan replaces project-related losses to fish and wildlife resources. Since concurrence with your comments does not necessitate any substantive changes to the draft FWCA report, we will not revise and reissue the report.

The planning process used for the Chaska Flood Control Project provides an outstanding example of interagency cooperation. In particular, we would like to commend the efforts of Ms. Jeannie Wagner of the St. Paul District and Mr. Tom Kucera of the Minnesota Department of Natural Resources for their participation on the tri-agency HEP team. The

professional working relationship between team members is extremely important in the HEP process and was outstanding on the Chaska project. We look forward to a continuation of such efforts on future projects.

These comments have been provided under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and are consistent with the intent of the National Environmental Policy Act of 1969.

Sincerely yours,

James C. Gritman

James C. Gritman
Acting Regional Director

cc: MN DNR, St. Paul, MN
U.S. EPA, Chicago, IL

FILMED

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